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THESIS

THE EFFECT OF ADVANCED EDUCATION ON THE RETENTION AND PROMOTION OF ARMY OFFICERS

by

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March 2007

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This thesis examines the relationship between advanced education and the retention and promotion of Army officers using data from the Active Duty Military Master File for Army officers who were commissioned between 1981 and 2001 and tracked until 2004 or until they separated from active duty.

Compared to an officer with a baccalaureate degree, the survival time of an officer with a master's degree, a doctorate degree, or a professional degree is greater by 29.1 percent, 23.9 percent or 8.2 percent, respectively. An officer with a master's degree, a doctorate degree, or a professional degree has a hazard of leaving the Army that is 38.3 percent, 44.4 percent, or 75.6 percent, respectively, of that of a college graduate.

Compared to an officer with a baccalaureate degree, time to promotion to O-4 for an officer with a master's/doctorate degree or a professional degree is 0.2 percent less or 2.4 percent less, respectively. An officer with a master's or doctorate degree has a hazard of promotion that is 115.3 percent of that of an officer with a college degree. Having a professional degree has no significant effect on the hazard of promotion.

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THE EFFECT OF ADVANCED EDUCATION ON THE RETENTION AND PROMOTION OF ARMY OFFICERS

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ABSTRACT

This thesis examines the relationship between advanced education and the retention and promotion of Army officers. It uses data from the Active Duty Military Master File for Army officers who were commissioned between 1981 and 2001 and tracked until 2004, or until they separated from active duty. Results of survival analysis indicate that survival functions differ significantly with level of education, and that advanced education has a positive effect on both the retention and promotion of Army officers.

Compared to an officer with a baccalaureate degree, the survival time of an officer with a master's degree, a doctorate degree, or a professional degree is greater by 29.1 percent, 23.9 percent or 8.2 percent, respectively. An officer with a master's degree, a doctorate degree, or a professional degree has a hazard of leaving the Army that is 38.3 percent, 44.4 percent, or 75.6 percent, respectively, of that of a college graduate.

Compared to an officer with a baccalaureate degree, the length of time to promotion to O-4 for an officer with a master's/doctorate degree or a professional degree is 0.2 percent shorter or 2.4 percent shorter, respectively. An officer with a master's degree or doctorate degree has a hazard of promotion that is 115.3 percent of that of an officer with a college degree. Having a professional degree has no significant effect on the hazard of promotion.

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I. INTRODUCTION

Organizations always seek to hire the most qualified personnel for the jobs that must be done at the lowest cost. The Armed Forces, one of the biggest organizations - or perhaps the biggest organization - also seeks to hire and retain qualified personnel. According to human capital theory, education increases productivity, which is a measure of qualification of the employee. Thus, hiring more educated people means hiring more qualified personnel.

The combat area is becoming more complicated in the 21st century, thus requiring more educated and qualified personnel. As a result, advanced education plays a critical role in shaping the combat field. Officers shape the combat environment by assessing different alternatives and making critical decisions. The main duty of an officer is not to shoot a gun; that is the job of enlisted personnel. The main duties of an officer are to follow the progress of battle, assess different ways of improving the achievements gained in battle on behalf of the allied forces, use the advantages of terrain for friendly forces, and choose the best course of action and execute it. In addition, the changing combat environment requires using information technologies in decision-making. Education can improve the ability to adapt more quickly to the changing environment.[1] In short, officers are decision-makers and decision-making requires following and analyzing the current situation.

Although technology has improved so much that most weapon systems can be directed by robotic systems or computers, it is still the human being who decides what to do and tells these machines what, how and when to do it. Eventually, humans use these machines to decrease the workload that must be executed by people, not to do the jobs that are done by officers. However, working with all these complicated systems requires advanced education, or, at least, education increases the utilization of those complicated

[1] Gregory A.Branigan, "The Effect of Graduate Education on the Retention and Promotion of Marine Corps Officers," (Master's thesis, Naval Postgraduate School, Monterey, California, 2001), 1.

systems. The need for and importance of highly-qualified personnel is increasing in the 21st century. Thus, the Army itself trains and educates officers to meet those requirements.

On the other hand, people themselves also make investments in education for the potential future returns they will yield. Employees take on three major kinds of labor market investments: education and training, migration and search for new jobs.[2] All these investments require an initial cost. As with all investments, these investments are made with the hope of future increased returns. This thesis focuses on the education and training investment aspect of labor market investment. For officers, one important potential future payoff is to be promoted to higher ranks in the Army. For the Army, the future hope is to retain the qualified officers and benefit from increased productivity and readiness.

A. BACKGROUND

There are four ways for Army officers to obtain advanced education degrees:

- Fully funded graduate education,
- Partially funded graduate education,
- Unfunded graduate education and,
- Fellowships and scholarships.

While pursuing a graduate degree under fully or partially funded graduate education policy, the officer receives full pay and allowances with the majority of the tuition and other schooling costs paid by the officer from personal funds and/or benefits to which the officer is entitled. The officer attends school instead of performing usual military duties. Under unfunded graduate education policy, the majority of tuition and other schooling costs are paid by the officer from personal funds and/or benefits to which the officer is entitled. The officer attends school during off-duty time.

Finally, military personnel may compete for non-military education level (non-MEL) fellowships or scholarships designed for education or training. They may be

[2] Ronal G.Ehrenberg, Robert S.Smith, *Modern Labor Economics, Theory and Public Policy*, (New York: Pearson Education, Inc, 2006), 275.

authorized to accept non-MEL fellowships or scholarships offered by eligible sponsors/donors for education or research in the United States or abroad.

Officers who attend fully funded courses at civilian institutions for more than 60 days will incur an Active Duty Service Obligation (ADSO) upon completion or termination of the education. The ADSO varies according to the way the degree is obtained, but the obligation is generally three times the length of the schooling.[3] Thus, this service obligation increases the retention rates of officers who obtain their advanced degrees by utilizing one of the methods that the Army provides. Unfunded graduate education requires no ADSO unless the officer uses tuition assistance.

B. OBJECTIVES AND RESEARCH QUESTIONS

The main objective of this thesis is to examine the relationship between advanced education and the retention and promotion of Army officers. There are four education categories used for the analysis: college degree only, master's degree, doctorate degree and professional degree. This analysis compares promotion rates among these four groups. For the purpose of this thesis, the officers' level of productivity and quality is measured by promotion rate.

In addition, the survival rates of the same groups of officers are compared by educational level. In this thesis, one of the Army's benefits from advanced education of officers is measured by retention. As a result of these comparisons, policy-makers may gain some insights into whether it is worthwhile to invest in different levels of advanced education.

Finally, factors other than education level that might affect the retention behavior and promotion patterns of U.S. Army officers are also analyzed in the multivariate models. Those factors include gender, marital status, military occupational specialty, commissioning source, age at commission, race/ethnicity and prior enlisted status.

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[3] *Army Regulation 350-100, Officer Active Duty Service Obligations*, (Washington, DC, Headquarters, Department of the Army, 5 May 2006), 4.

Although the aim of this research is not a cost-benefit analysis, this study tries to determine if it is worthwhile for the Army to pay for advanced education. If the productivity of the officers does not increase or if they are not retained long enough after obtaining their degrees, then it may not be worthwhile for the Army to pay for graduate education.

The retention probabilities of officers with or without graduate degrees are also important for the Army because the officers who obtain these degrees should stay long enough in the Army to offset their education costs. If officers with graduate degrees leave the Army earlier than those without such degrees, then it may not be worthwhile for the Army to pay for this education.

As explained above, the main objective of this thesis is to analyze the effect of advanced education on retention and promotion. Thus, based on the main objectives, there are two primary research questions:

1. Does any kind of advanced education affect the retention behavior of U.S. Army officers?

2. Does advanced education increase the probability of being promoted to MAJOR (grade of O-4)?

The answers to these questions provide information on whether advanced education has a significant effect on retention behavior and promotion probabilities of officers. Differences among four groups of officers are considered: college graduates, those with master's degrees, those with doctorate degrees and professional degree holders.

Beyond these two fundamental questions there are four supplementary questions which are addressed in this thesis. These are:

1. What are the factors, other than education level, which affect the retention behavior of U.S. Army officers?

2. What are the factors, other than education level, which affect the promotion of U.S. Army officers?

3. Are there significant differences in survival rates between officers with and without advanced education degrees?

4. Are there significant differences in promotion probabilities to MAJOR (O-4 grade) between officers with and without advanced education degrees?

C. METHODOLOGY

The data set used for this thesis was created from the Active Duty Military Master File, which is supplied by the Defense Manpower Data Center. The data provide information about Army officers who were commissioned between 1981 and 2001. The officers in each cohort are tracked until 2004 or until they separate from active duty.

Survival Analysis is used as an empirical approach in this thesis. Survival models are estimated both for promotion patterns and for the retention of Army officers. Three SAS software procedures are used for estimating survival models: PROC LIFETEST, PROC LIFEREG and PROC PHREG. As a result of these analyses, it is possible to evaluate how promotion and retention rates vary among officers with different education levels.

D. LIMITATIONS

The data set has several limitations. It does not provide information about how graduate degrees were obtained or from where they were obtained. Thus, in the thesis, officers are not distinguished by how they obtained their degrees. Moreover, they are not classified according to the colleges they attended.

Other factors such as college GPA, physical training reports, performance reports, the quality of the college attended and rewards, were used as explanatory variables in some previous studies and might affect promotion and retention of U.S. Army officers. However, they are not available in the data set and could not be used for the analysis.

E. ORGANIZATION OF THE STUDY

This thesis comprises seven chapters. The first chapter is an introduction. The second chapter is titled “Graduate Education and Promotion Policy of the United States

Army." This chapter discusses the available ways for officers to obtain graduate degrees, the eligibility requirements for graduate education, and service obligations related to graduate education. In addition, promotion policy of the U.S. Army is also explained in Chapter II. Chapter III provides a literature review. This chapter first briefly explains human capital theory, and then previous studies related to the effect of graduate education. Chapter IV briefly discusses the empirical method used for the analysis, which is survival analysis. It also explains the three SAS procedures used in this study, PROC LIFETEST, PROG LIFEREG and PROC PHREG. Moreover, it lists and describes the variables used for the analysis and the hypothesized effects of independent variables on retention and promotion. Chapter V is about the data and includes a preliminary data analysis. The structure of the data used for thesis is described in this chapter. Additionally, Chapter V also presents descriptive statistics. Chapter VI shows the results of survival analysis. The first part of this chapter presents the results for the retention model, and the second part gives the results of promotion analysis. The last chapter, Chapter VII, presents a summary of the results of the study and also provides recommendations.

II. GRADUATE EDUCATION AND PROMOTION POLICY OF THE UNITED STATES ARMY

For the purpose of this thesis, graduate education is defined as studies beyond the bachelor's degree or at the first professional degree level. According to this definition, the master's degree and the doctorate degree meet the criteria for graduate education. Furthermore, since professional degree holders also have advanced education levels, usually beyond the baccalaureate degree, these officers' promotion and retention patterns are also investigated.

This chapter describes the relationship between graduate education and the promotion policy and service obligations related to graduate education of the United States Army. It first explains the graduate education policy, and then the service obligations related to graduate education. Finally, it discusses promotion policy and service obligations.

A. GRADUATE EDUCATION POLICY OF THE UNITED STATES ARMY

It is Department of Defense (DoD) policy to fund graduate education fully and partially for Active Duty (AD) military officers when the education is required to fill Military Service requirements for validated positions.[4] Thus, the priority in graduate education is the Army's needs.

There are four ways for United States Army officers to obtain a graduate degree. These include fully funded graduate education, partially funded graduate education, unfunded graduate education, and fellowships and scholarships. Eligibility requirements and service obligations differ for each of these graduate education options.

1. Fully Funded Graduate Education

Under the fully funded graduate education option the officer receives full pay and allowances while pursuing a graduate degree, with the majority of the tuition and other

[4] *Department of Defense Directive 1322.10, Policy on Graduate Education for Military Officers,* (Washington, DC: Headquarters DoD, 26 August 2004), 2.

schooling costs assumed or paid by the U.S. Government or by another organization. The officer attends school instead of performing usual military duties. [5]

The length of schooling will vary with the curriculum, but will not normally exceed 18 months of continuous full-time study. (Graduate study to prepare for an assignment to the staff and faculty at United States Military Academy may require 18 to 24 months.) To meet validated Army Educational Requirements System (AERS) requirements by specialty and grade, participants agree to study in an academic discipline consistent with the officer's designated specialties. In cases where this does not occur, the officer will be awarded an appropriate supported specialty.[6]

a. Eligibility[7]

- *Status.* Commissioned officers must be on active duty and serving in Regular Army or in Voluntary Indefinite status at the time of application and selection. Soldiers must agree in writing to fulfill any service obligation incurred by acceptance of training or schooling.
- *Potential.* A review of the candidate's career management individual file (CMIF) must reflect that the officer has potential for future, long term service, as determined by U.S. Total Army Personnel Command (PERSCOM).
- *Interest.* Officers must express specific interest in training by signing and submitting a formal application.
- *Branch Qualification.* Commissioned officers must have completed the Captain Professional Military Education (to include the perspective branch advanced course and Combined Arms and Service Staff School), and be branch qualified at company grade level prior to being selected for advanced civilian schooling.
- *Minimum academic requirements.* Officers must have completed a baccalaureate degree with a minimum grade point average (GPA) of 2.5. If an officer

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[5] *Department of Defense Directive 1322.10, Policy on Graduate Education for Military Officers,* 6.

[6] *Army Regulation 621-21, Training of Military Personnel at Civilian Institutions,*(Washington, DC: Headquarters, Department of the Army, 20 August 1999), 16.

[7] Ibid., 16-17.

holds more than one completed baccalaureate degree, the highest GPA will be considered. Minimum scores for the Graduate Record Examination test (GRE) must be 500 in each of the three academic areas (verbal, quantitative, and analytical), and for the Graduate Management Admission Test (GMAT), minimum score must be 500.

b. Funding[8]

- *Tuition.* PERSCOM pays all tuition and fees for students enrolled in the fully funded program. Certain fees will not be paid, such as health insurance, parking passes, student IDs, and transcript and graduation fees.
- *Book Allowance.* Students will receive an initial payment of $600 upon entry into schooling to support application fees, books, and start-up costs. Students will then receive an allowance to defray the cost of books in the amount of $200 upon the completion of each semester. In addition, students are reimbursed up to $200 for a master's thesis or $500 for a Ph.D. dissertation.

2. Partially Funded Graduate Education[9]

While pursuing a graduate degree, the officer receives full pay and allowances with the majority of the tuition and other schooling paid by the officer from personal funds and/or benefits to which the officer is entitled. The officer attends school instead of performing usual military duties.

3. Unfunded Graduate Education[10]

While pursuing a graduate degree, the majority of tuition and other schooling costs are paid by the officer from personal funds and/or benefits to which the officer is entitled. The officer attends school during off-duty times.

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[8] *Army Regulation 621-21, Training of Military Personnel at Civilian Institutions*, 19.

[9] *Department of Defense Directive 1322.10, Policy on Graduate Education for Military Officers*, 6.

[10] Ibid.

4. Army Fellowships and Scholarships[11]

Department of the Army personnel may compete for non-military Education Level (non-MEL) fellowships or scholarships with educational or training purposes. They may compete for and accept non-MEL fellowships or scholarships offered by eligible sponsors/donors for educational purposes or research in the United States or abroad.

a. Eligibility[12]

Commissioned officers must be on active duty status in an active or reserve component of the Army in order to be eligible to compete for a non-MEL fellowship or scholarship. Officers may not compete for multiple non-MEL programs. An officer cannot have more than 19 years of Active Federal Commissioned Service.

B. SERVICE OBLIGATIONS RELATED TO GRADUATE EDUCATION

1. The DoD's Policy on Service Obligation Related to Graduate Education[13]

Officers who have received a fully funded or partially funded graduate education are required to serve on Active Duty (AD) for the time period specified. This service obligation varies with the civilian schooling opportunity and the length of the schooling.

Officers who have received a fully funded or partially funded graduate education opportunity and who, voluntarily or because of misconduct, fail to complete the period of AD obligation specified in return for that educational opportunity, are required to reimburse the United States the amount specified.

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[11] *Army Regulation 621-7, Army Fellowships and Scholarships,* (Department of the Army Headquarters, Washington, DC, 8 August 1997), 2.

[12] Ibid.

[13] *Department of Defense Directive 1322.10, Policy on Graduate Education for Military Officers*, 3.

2. The Army's Policy on Service Obligation Related to Graduate Education

Officers who attend fully funded courses at civilian institutions for more than 60 days will incur an Active Duty Service Obligation (ADSO) upon completion or termination of the education. The ADSO will equal 3 times the length of the schooling.[14]

Officers who accept statutory fellowships and scholarships incur an ADSO on completion or termination of the education. The ADSO will equal three times the length of schooling, computed in days, and may exceed 6 years.[15]

Officers who participate in partially funded programs for more than 60 days incur an ADSO upon completion or termination of the education. The ADSO will equal three times the length of the schooling.[16]

Officers participating in scholarship or grant programs incur an obligation and must agree, in writing, to remain on active duty upon completion or termination of training/education for a period of not less than three times the length of the training or education, computed in days.[17]

Officers participating in non-MEL fellowships incur, and must agree in writing, to an active duty service obligation of two years.[18]

C. OFFICER PROMOTIONS

1. DoD's Policy on Officer Promotions

While the process of promoting to fill requirements in the grades O-4 through O-6 by competitive category may result in different promotion timing and opportunity for certain competitive categories, promotion opportunity in a category is expected to be

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[14] *Army Regulation 350-100, Officer Active Duty Service Obligations,* (Washington, DC, Headquarters, Department of the Army, 5 May 2006), 4.

[15] Ibid.

[16] Ibid.

[17] *Army Regulation 621-7, Army Fellowships and Scholarship,* 3.

[18] Ibid.

relatively similar over a five-year period.[19] Promotion of officers serving on the Active Duty List[20] under promotion timing and minimum opportunity is provided in Table 1.[21]

Table 1. Desired Active Duty List Promotion Timing and Opportunity

TO GRADE	TIMING	OPPORTUNITY
O4	10 YEARS +/- 1 YEAR	80 percent
O5	16 YEARS +/- 1 YEAR	70 percent
O6	22 YEARS +/- 1 YEAR	50 percent

Source: From *Department of Defense Instruction 1320.14, Commissioned Officer Promotion Program Procedures,* (Washington DC, Headquarters, Department of Defense, 24 September 1996)

It is recognized that promotion opportunity and timing, as determined by the Secretary of the Military Department, may vary from the targets in Table.1 based on needs.[22] Thus, the important thing for promotion is the service's needs. So, timing will be different according to each officer's productivity. As a result, this study examines the relationship between education level and promotion.

The number of officers on the Active Duty List or the Reserve Active Status list[23] may be recommended for promotion to the grades of colonel and below from among those being considered from below the promotion zone.[24] In any competitive category

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[19] *Department of Defense Instruction 1320.13, Commissioned Officer Promotion Reports (COPRs) and Procedures,* (Department of Defense Headquarters, Washington DC, 21 June 1996), 4.

[20] Active Duty List is a single list for the Army that contains the names of all officers of that Military Service, other than warrant officers, who are serving on active duty.

[21] *Department of Defense Instruction 1320.14, Commissioned Officer Promotion Program Procedures,* (Washington DC, Headquarters, Department of Defense, 24 September 1996), 4.

[22] Ibid., 5.

[23] Reserve Active Status List is a single list for the Army which contains the names of all officers of that Armed Force, except warrant officers, who are in an active status in a reserve component of the Army and not on an Active Duty List.

[24] The below-the-zone promotion capability is the accelerated promotion of outstanding officers who have demonstrated performance and indicated potential clearly superior to those who otherwise would be promoted. Below-the-zone promotions apply only to promotion to the grades of major, lieutenant colonel and colonel.

the number may not exceed a number equal to 10 percent of the maximum number of officers to be recommended for promotion in such competitive category.[25] The Secretary of Defense may authorize a greater number, not to exceed 15 percent of the total number of officers that the board is authorized to recommend for promotion, if he or she determines that the needs of the Service so require.[26]

2. Army's Policy on Officer Promotions

The Army's policy is contingent on the DoD's policy. The timing and promotion opportunities are the same. In the Army, approximately 80 percent of officers can make it to O-4 in ten years according to DoD's policy, which is the main focus of this study.

a. Promotion Eligibility[27]

- To be considered for promotion by a selection board, an officer must be on the active duty list (ADL) on the day the board convenes.
- *Second Lieutenant (2LT) and First Lieutenant (1LT).* The law establishes no minimum Time in Grade (TIG) requirements for consideration for promotion; however, an officer must have at least 18 months TIG to be promoted to 1LT and two years TIG to be promoted to Captain (CPT). The TIG requirement for promotion to 1LT has been extended to two years by the authority of the Secretary of the Army (SA).
- *CPT, Major (MAJ), and Lieutenant Colonel (LTC).* These officers must serve at least three years TIG to be considered for promotion. This requirement may be waived by the SA, for consideration from below the zone.
- *Colonel (COL).* Officers must serve one year TIG to be considered for promotion. If selected, they may be promoted without regard to any additional TIG requirements.

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[25] *Department of Defense Instruction 1320.1, Commissioned Officer Promotion Reports (COPRs) and Procedures,* 5.

[26] Ibid.

[27] *Army Regulation 600-8-29, Officer Promotions* (Department of the Army Headquarters, Washington DC, 25 February 2005), 2-3.

- TIG requirements for the Army commissioned officers are presented in Table.2.

Table 2. Time in Grade Requirements for Commissioned Officers

From	To	Minimum Years in Lower	Maximum Years in Lower
O1(2LT)	O2(1LT)	2	42 months
O2(1LT)	O3(CPT)	2	5
O3(CPT)	O4(MAJ)	3	7
O4(MAJ)	O5(LTC)	3	7
05(LTC)	O6(COL)	1	Announced annually. Normal TIG is five years, subject to the needs of the Army.

Source: After *Army Regulation 600-8-29, Officer Promotions* (Department of the Army Headquarters, Washington DC, 25 February 2005), and *Army Regulation 135-155, Promotion of Commissioned Officers and Warrant Officers Other Than General Officers* (Department of the Army Headquarters, Washington, DC, 13 July 2004).

b. Selective Continuation[28]

- Subject to the needs of the Army, officers pending separation because of having twice failed to be selected for promotion to MAJ or LTC may be selectively continued on active duty in their present grade.
- Selectively continued officers, if otherwise eligible, will continue to be considered for promotion until separation.
- Continuation for captains and majors who are more than six years from qualifying for retirement will normally be from the date the officer would otherwise have been separated for having twice failed to be selected for promotion, or until the last day of the month in which the officer first becomes eligible for retirement under any provision of law - whichever is earlier. The SA may adjust the period of selective continuation.

28 *Army Regulation 600-8-29, Officer Promotions*, 5.

- Selectively continued majors within six years of qualifying for retirement will be continued on active duty until eligible for retirement under the provisions of USC Title 10, section 3911 (unless sooner discharged under other provisions of law or regulation). They will be retired (if they apply) or discharged.

D. CHAPTER SUMMARY

This chapter first establishes a definition of graduate education for the study. It then explains the various modes of acquiring graduate education, as well as their respective eligibility requirements. These methods include fully funded, partially-funded, unfunded graduate education and Army fellowships and scholarships. The chapter further defines the Army's promotion policy, as well as timing and eligibility. To be considered for promotion by a selection board, an officer must be on the active duty list on the day the board convenes. Officers should serve at least nine years after commissioning and three years as captain in order to be promoted to the rank of MAJOR (O-4).

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III. LITERATURE REVIEW

The returns of education are generally measured in terms of increased earnings and more frequent promotions for individuals with a higher level of education. For firms or organizations, returns are measured in terms of increased productivity and retention. This chapter explains human capital theory and its application in the Army. It then summarizes and discusses studies related to retention and promotion. This chapter also provides a close examination of studies explaining the effect of graduate education on retention or promotion, or both.

A. HUMAN CAPITAL THEORY

That education is an investment is one of the main concepts of human capital theory. People invest in additional education if the present value[29] of additional future earnings exceeds the present value of costs, or they invest if the return on investment is greater than their discount rates.

Human capital theory claims that expenditure on training and education should be considered an investment since it is assumed that personal income is later increased as the result of current expenditures on training and education.[30] The human capital approach is often used to explain occupational wage differentials.[31] In the Army, compensation differs according to the ranks. So, if an officer is promoted more rapidly, then he or she increases his or her earnings.

People who learn easily and rapidly are more likely to acquire advanced education. Furthermore, their decisions about advanced education are also affected by

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[29] Present value is discounted value of future earnings or investments. For more information, see Ronald G. Ehrenberg and Robert S. Smith, *Modern Labor Economics,* 9th ed. (New York: Pearson Education, Inc, 2006).

[30] G S Becker, *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education* (New York, 1964), <http://www.economyprofessor.com/economictheories/human-capital-theory.php> (accessed October 9, 2006).

[31] Ibid.

their expectations about their future earnings.[32] When workers make investments in education and training, the expected returns are higher future earnings, increased job satisfaction over their lifetimes, and other quality of life improvements.[33]

Education level is used as a screening device by most employers. Acquiring a higher level of education requires hard work and study, which may correlate with capability. People who find learning to be especially difficult will think that acquiring education requires a higher marginal cost.[34] Individuals with higher marginal costs will acquire lower levels of human capital.[35] If those who have lower costs of acquiring education are also of higher ability and are more productive on the job, then educational level can serve as a useful criterion for employers in screening for employment and promotion.[36]

Based on this idea of education level as a screening device, one may consider officers who invest in education to be those who learn easily and quickly. In addition, one might consider officers who learn easily to be of higher ability and more productive on the job. In this study, the proof of productivity is promotion. If officers with graduate degrees are promoted at a greater rate than those without graduate degrees, then they are considered more productive. Moreover, officers in the same rank who serve in the same geographic area and perform the same job, receive the same pay. In order for the officer to obtain returns on education, he or she must be promoted to a higher rank in a shorter period of time. Only if an officer is promoted do his or her earnings increase.

Another concept related to investment in education and training is that increased education results in increased job satisfaction in the future. According to this idea, officers who have graduate degrees will have increased satisfaction in their jobs. As a

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[32] Ronald G. Ehrenberg and Robert S. Smith, *Modern Labor Economics,* 9th ed. (New York: Pearson Education, Inc, 2006), 277.

[33] Ibid.

[34] Ibid., 280.

[35] Ibid., 281.

[36] Ibid., 303.

result of their increased job satisfaction, officers with graduate degrees can be expected to stay in the Army longer than officers without those degrees.

Most of the training and education costs for officers are borne by the Army. In this case, we can also apply human capital theory to the Army. The Army expects increased retention and higher productivity as a result of its educational investments. In fact, retention is directly impacted by the service obligations owed by the officers whose education costs are paid by the Army. In short, benefits of higher education for the Army are increased retention, manning readiness, and increased productivity, measured by promotion.

Finally, the Armed Forces provide a good example of promotion tournaments. A promotion tournament is a kind of employee motivation method that is common in the environment of an internal labor market.[37] Tournaments have three important features. First, the winner is not known at the beginning, so everybody has a chance to win. Second, the winner is selected based on performance, which is compared with other contestants' performances. Third, the rewards should be large enough that there would be substantial differences between losers and winners. Thus, tournaments have two purposes: to motivate all employees and reward hard-working employees. Tournaments work in the military by promoting successful officers to a higher rank, and providing increased earnings and higher management level jobs.

There is no commander who has been assigned directly to any level of command duty who has not served at the previous level. For example, in order to be a battalion commander, an officer must first serve as a company commander, and then he or she can be promoted to the next rank. Each officer begins at a very low level (usually O-1) and makes his or her way up to higher levels. Thus, this study examines how graduate education affects the promotion tournament.

[37] Ehrenberg and Smith, 376, 377.

B. LITERATURE DISCUSSION

Although there are many studies related to the effect of education on Navy and Marine Corps officers, studies dealing with the effects of education for Army officers are not as common. For this reason, some of the studies discussed in this chapter are related to services other than the Army.

1. Study by Buterbaugh (1995)

In his master's thesis, "A Multivariate Analysis of the Effects of Academic Performance and Graduate Education on the Promotion of Senior U.S. Navy Officers," Thomas A Buterbaugh examined the effects of undergraduate background and fully-funded graduate education on promotion to the ranks of Commander (O-5) and Captain (O-6) in the Navy. For the purpose of this thesis, only the section of Buterbaugh's study pertaining to graduate education is discussed.

Buterbaugh used the officer promotion history files from 1981 to 1994 to obtain data for his analysis. The data set included all Navy officers who appeared before Commander and Captain promotion boards during those years. He analyzed five warfare communities in his study: Surface Warfare Officers (SWO), Submarine Warfare Officers, Pilots, Naval Flight Officers (NFOs), and combined Fleet Support and Supply officers. Furthermore, he obtained results for the aggregation of these five communities.

Buterbaugh's dependent variable in the study was PROMOTED, which was equal to one if an officer was promoted to O-5 or O-6, and zero if an officer was not promoted to O-5 or O-6. His first explanatory variable was Fully-Funded Graduate Education (FFGE), which had values of zero or one (one, if an officer had a graduate degree). The other explanatory variables were gender, race, officer's undergraduate performance, the "quality" of undergraduate education institute attended, whether or not the undergraduate degree was in a technical field of study, marital status, kids (=1 if married with dependent children), and prior enlisted background. For the aggregate model, he also used career paths as an explanatory variable. He did not use gender as a variable in the Submarine model, since there are no female officers in this community.

Buterbaugh used linear regression and Probit models in his study. His reason for using these models was that the binary nature of the dependent variable PROMOTED allowed for estimation of multivariate models using both ordinary least squares (OLS) for Linear Probability Models, and maximum likelihood procedures for Probit models.[38]

Results of OLS aggregate model showed that officers with a fully-funded graduate degree had higher probabilities of being promoted to the rank of Commander by 8.7 percent. Logit model results were approximately the same as OLS results. His other findings as a result of OLS model were as follows:

- Officers who had superior undergraduate academic performance had higher probabilities of being promoted to the rank of Commander by 6.6 percent.
- Officers who were male, white, United States Naval Academy (USNA) graduates and with at least one child had higher promotion probabilities.
- Officers who were enlisted before being commissioned as officers, and whose undergraduate degrees were in math-intensive or engineering fields were less likely to be promoted to O-5.

The results for the promotion to Captain (O-6) model were a little bit different. According to this model, graduate education had no significant effect on promotion to O-6. Other findings for this model were as follows:

- Higher undergraduate academic performance, being a USNA graduate and having dependent children had positive effects on promotion to Captain.
- Prior enlisted officers had a lower probability of being promoted to Captain.
- Gender, race, marital status, and dependent children had no significant effect on promotion to Captain.

Buterbaugh also conducted analyses for separate officer communities. In the promotion to O-5 model, only Surface Warfare, Fleet Support and Supply officers

[38] Thomas A.Buterbaugh, "A Multivariate Analysis of the Effects of Academic Performance and Graduate Education on the Promotion of Senior U.S. Navy Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 1995), 22.

revealed significant positive effects of graduate education. On the other hand, in the promotion to O-6 model, graduate education had a positive significant effect only for the Fleet Support and Supply officers.

One weakness of his study is that selection bias is not mentioned. It is likely that the officers who were selected for graduate education, and thus obtained graduate degrees, were the officers who would be promoted anyway. [39] In addition, they might have been selected for graduate education because of their past achievements in their jobs. On the other hand, the limitations of the data set affected the scope of the study. For example, adding the performance report of an officer during the command tour might reveal better results.[40] However, because of the lack of the variable in the data set, he was not able to use this variable in the analysis.

2. Study by Wielsma (1996)

In his master's thesis, "An Analysis of Factors Affecting Promotion, Retention and Performance for USMC Officers: A Graduate Education perspective," Ronald J.Wielsma analyzed the factors associated with promotion to O-4, retention to the O-4 point, and actual performance ratings for Marine Corps officers.[41] He focused especially on the effect of graduate education on measures of on-the-job performance.

Wielsma collected data from the Defense Manpower Data Center (DMDC), the Marine Corps Automated Fitness Report System (AFRS), the Headquarters Master File (HMF), the Official Military Personnel File, and specific data from Marine Corps Headquarters. He combined all data from different sources into one file to use for analysis. He used officers who were commissioned in 1980 for his analysis.

For the retention model, the dependent variable Wielsma used was STAYPROM, which was equal to one if the officer stayed to the O-4 promotion point and zero if he or

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[39] Buterbaugh, 46

[40] Ibid.

[41] Ronald J.Wielsma, "An Analysis of Factors Affecting Promotion, Retention and Performance for USMC Officers: A Graduate Education perspective", (Masters' thesis, Naval Postgraduate School, Monterey, California, 1996)

she did not stay to the O-4 promotion point. For the promotion model, the dependent variable was PROMOTE, which was equal to one if the officer was promoted to O-4, and zero if he or she was not promoted to grade 4 level.

He defined explanatory variables in three different groups as follows:

- Cognitive Skills (General Classification Test Score taken upon entry, composite ranking at the basic school and graduate degree);
- Affective Traits (Commissioning sources, prior enlisted situation, and MOS's); and
- Demographic Traits (Age at entry, race, gender, marital status and unemployment rate).

Wielsma used Probit models for his analysis. In one model, he analyzed the effect of graduate education on retention, and in a second model he analyzed the effect of graduate education on promotion to O-4. He found that actual on-the-job performance is an important factor in determining retention and promotion.[42]

For the analysis of promotion, he ran several different models, each time adding different additional explanatory variables to the model in order to get rid of potential omitted variable bias. First he ran the simple model, in which the dependent variable was PROMOTE (promotion to O-4), and explanatory variables were composite ranking at the basic school (COMPRK), graduate education background, level of education (OBPGRAD, which is equal to one if an officer obtained a postgraduate degree since entering the Marine Corps), the officers' MOS, the officers' commissioning source, minority, marital status and gender. Second, he ran the same model but added the score for the General Classification Test (GCT), which is taken upon entry, to the model as an explanatory variable. Third, he ran the model again, removing GCT and adding Average Performance Index to the previous model. The marine corps officers are evaluated according to their characteristics and on-the-job achievements. Those scores are summed and then divided by the number of observed marks to find an average index for each officer. This average index shows the officers' evaluated performance. Finally, he ran

[42] Wielsma, 39-56.

another model, adding both these two independent variables. He concluded that, of those four models, the third one, which added only Average Performance Index, was the best of the promotion models.

Wielsma pointed out that there might also be sample selection bias in his models due to the fact that officers selected for graduate education are more likely to be promoted because of the selection process, even without graduate education. Selection bias might be caused by differences in characteristics between those who stay long enough for promotion to O-4 and those who do not stay (unobserved). In order to correct for sample selection bias he used the Heckman model.

In the retention model, again, to get rid of omitted variable bias, he used two models: the first one was the simple model, and second one was obtained by adding Average Performance Index of officers to the first model. In the simple model the dependent variable was staying until O-4 point (STAYPROM) and the independent variables were cognitive skills, affective traits, and demographic treats. In the first model he excluded the average performance index (AVGPI) from the model, and in the second one, he added this variable to the model. He found that the second model was superior.

Wielsma's aim was to find the direction of the relationship between graduate education and retention and promotion. Thus, he concluded that graduate education and retention and promotion were positively correlated. His other findings are as follows:

- An officer's General Classification Test Score and occupational community have no significant effect on both retention and promotion.
- Individual demographic characteristics are not significant in the promotion model.

According to Wielsma, the size of the data sample and the contents severely limited the full analysis of explanatory variables. The variables were not recorded well before 1986. For this reason, some of the independent variables which were used in previous studies were not available in his study, such as fitness reports and college grade point average. For example, he wanted to compare the fitness reports before and after

obtaining graduate degrees, but it was not possible to create a performance variable to document the before and after treatment effects, due to a lack of necessary information.[43]

3. Study by Mehay and Bowman (1998)

In their study "Graduate Education and Employee Performance: Evidence from Military Personnel," William R. Bowman and Stephen L.Mehay examined the specific relationship between graduate education and on-the-job performance for officers in the United States Navy.[44] In their study, the main question was whether the relationship between education level and earnings is due to learning or sorting by employers; that is, they wanted to find out if an increase in education level also increased earnings. Thus, if rank of an officer with a graduate degree increased faster than for an officer without a graduate degree, then this result would confirm a positive relationship. The objective of the study was to examine job success for Navy officers.

Mehay and Bowman mainly used the Navy's Promotion History File in order to obtain data to use in their analysis. These data provided background information about all Navy officers who were reviewed for promotion between 1985 and 1990. They augmented this file with supervisor evaluations (fitness reports) before the O-4 promotion review. Officers are classified into two occupational categories in the Navy – line and staff.[45] Line specialists work in the primary operational areas of the Navy, such as aviation, ship operations and submarine operations. Staff officers primarily perform administrative functions, and provide specialized support to line officers. Staff functions in the Navy include medical, dental, personnel, legal, supply and religious occupations. After deleting observations with missing data, the data file used for the analysis contained 4,230 line officers and 2,353 staff officers.

According to the authors, using data from a military organization would provide perfect information for this kind of analysis, since military organizations do not usually

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[43] Wielsma, 61.

[44] William R. Bowman and Stephen L. Mehay, "Graduate Education and Employee Performance: Evidence from Military Personnel," *Economics of Education Review* (1998)

[45] Ibid., 455.

allow lateral transfers from any other organization. All officers must begin their careers in entry-level positions. Most advanced education is obtained after participating in the organization and it is mostly funded by the military. According to Mehay and Bowman, the important implication of hierarchical organizational forms such as the military, is that the direct and indirect span of control increases with rank.[46]

Mehay and Bowman used several different models to find the effect of graduate education on promotion to O-4, adding explanatory variables each time to the model. In general, they found that graduate education has a positive effect on promotion to grade 4; however, these effects are significantly reduced in instrumental variable estimates that adjust for selection bias.[47] According to their findings, the marginal effect of graduate education is 0.098 and 0.145 for line and staff officers respectively. However, when they include additional variables, the marginal effect decreases to 0.065 for line officers and to 0.089 for staff officers.

They first estimated a Probit promotion model to test whether graduate education has a measurable effect on the performance of an officer, which was measured by promotion probability. In this model, they found that any graduate education degree had a significantly positive effect on promotion to grade 4. Officers with graduate degrees had 10-15 percentage points higher promotion probabilities than those without graduate degrees. Female, younger, and married officers were also more likely to be promoted. The promotion probability for minorities was lower than for other officers. The promotion probability of Naval Academy graduates was significantly higher than that of the other accession sources.[48]

However, when instruments that are uncorrelated with promotion are used to predict graduate degree status, the results suggest that a sizeable portion of the relationship between graduate education and promotion is due to unobserved attributes that lead some people to attend (or be selected for) graduate school, especially for the

[46] Bowman and Mehay, 455, 456.

[47] Ibid., 454.

[48] Ibid., 456

Navy's program, and to become more promotable.[49] The selection-corrected estimates of the promotion effect of graduate education are reduced by between 40 and 50 percent.[50]

Mehay and Bowman concluded that graduate education increased skills and provided a mechanism to sort individuals who had the greatest value to the Navy. Individuals who are more career-oriented signal these attributes by means of their willingness to attend graduate school. Among career-oriented officers, the Navy selects those whose early performance indicates greater potential for jobs at the upper levels of the organization.[51]

4. Study by Branigan (2001)

In his thesis, "The Effect of Graduate Education on the Retention and Promotion of Marine Corps Officers," Gregory A.Branigan examined the relationship between graduate education and retention and promotion in the Marine Corps. He estimated the effect of graduate degrees either from the Naval Postgraduate School (NPS) or from sources other than NPS on the promotion and retention of Marine Corps officers.

Branigan collected data for his study from different sources. He obtained Promotion Board Data for majors who had been considered for promotion to lieutenant colonel from FY 1998 to FY 2001. He also obtained Cohort Data from the Center for Naval Analysis for officers who had been commissioned between 1974 and 1984, who remained on active duty after November 1984. He collected additional cohort data from the Defense Manpower Data Center (DMDC) West, and the Manpower Information (MI), and Performance Evaluation divisions at Headquarters Marine Corps. He also obtained data regarding graduate education from the Naval Postgraduate School for those officers who graduated from NPS between 1983 and 2000. Finally, he merged all these data files to construct a single file for analysis. There were 6,507 officers commissioned as O-1's in this file, which he called the Accession Cohort Sample.

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[49] Bowman and Mehay, 461

[50] Ibid.

[51] Ibid.

For analysis of promotions, Branigan created a second data file from the first file by selecting officers who served on active duty long enough to be considered for promotion to O-5. He called this file the "Promotion Sample". This file was drawn as a subset of the Accession Cohort Sample.

Branigan used Probit Models for both retention and promotion outcomes. He chose the Probit Model because the outcomes of the research were binary. He used two different models for each analysis. One included a variable for all officers who had master's degrees and another one divided officers in two groups, those who obtained degrees from NPS and those who obtained degrees from any other source. He used the Heckman sample selection correction method to adjust for sample selection bias.

His model specification was based on Wise (1975), Wielsma (1996) and Bowman and Mehay (1999). His dependent variable for the retention model was SURVIVE, which was equal to one if the officer survived to the O-5 board, and zero if not. For the promotion model, the dependent variable was SELECT, which was equal to one if the officer was selected for O-5, and zero if he or she was not selected.

He classified explanatory variables in five groups as follows:

- Performance Traits (Performance Evaluation Index, College Grade Point Average, personal awards, intermediate school completion);
- Cognitive Traits (Education level, degree from NPS or other school and General Classification Test Score);
- Affective Traits (commissioning sources, Military Occupational Specialties (MOS) and Combat Fitness Report results);
- Demographic Traits (age at commissioning, Marital status, number of dependents, gender and race); and
- Career Traits (national unemployment rate and whether an officer was in-zone in O-5 Board in 1988, 1999, 2000, or 2001).

Branigan found that an officer with a master's degree is 12 percent more likely to survive and 15 percent more likely to be promoted than an officer who does not have an advanced degree. An officer who obtained a degree from NPS is 10.6 percent more likely to survive and 10.7 percent more likely to be promoted than an officer who does not have

a master's degree. An officer who obtained a graduate degree from any source other than NPS is 12.5 percent more likely to survive and 16.7 percent more likely to be promoted than an officer who does not have a graduate degree. For both promotion and retention, the effect of having a graduate degree from any source other than NPS was greater than the effect of having a degree from NPS. His other findings were as follows:

- Officers with a higher performance index, with more dependents, with combat experience, aviators and officers who had been married were more likely to survive until the O-5 promotion point.
- Officers with active duty enlisted experience and males were less likely to survive to the O-5 promotion point.
- Officers who had higher performance index, a greater number of rewards, completed their intermediate-level Professional Military Education, were younger at the time of commissioning and who were female were more likely to be selected for promotion to O-5.
- Aviators and those from aviation support MOS's were more likely to be promoted than those in combat arms MOS's.

Branigan thought that the limitations for the study were due to insufficient data. The inclusion of graduate education from MPE institutions in the NON_NPS variable could be the dominant factor in the findings of the study. For this reason, he pointed out that his findings should not be used for policy decisions.

5. Study by Fagan (2002)

In his master's thesis, "Analysis of Determinants of Training Performance, Retention, And Promotion to Lieutenant Commander of Naval Flight Officers," Billy K.Fagan analyzed the effect of different characteristics on training performance, retention, and promotion of Naval Flight Officers (NFOs). One of these characteristics was graduate education. For the purpose of this study, only the parts of this study pertaining to retention and promotion are summarized.

Fagan used the "All Officers" data set in his analysis. The data set included 34,724 naval officers who were commissioned from 1983 to 1990. He created an "NFO data set" from this main data set. There were 4,490 observations in this data set.

For his retention model the dependent variable was LCDRSTAY, which was equal to one if an officer retained until the LCDR promotion board, and zero if an officer did not stay to that point. The dependent variable for his promotion model was also binary and called LCDRPROM, which was equal to one if an officer was selected for LCDR promotion, and zero if an officer was not selected for promotion.

Fagan defined his independent variables in two major groups. The first group was personal characteristics, which consisted of gender, race/ethnicity, age at commissioning, undergraduate major, Barron's code (BC), and dependent status. The second group was called professional characteristics and included prior enlisted situation, carrier, graduate education status, lateral transfers, months to wing, and quality of NFO.

Fagan used a Probit model specification in the analysis. He ran two different models, one for retention and one for promotion. (A third model was estimated for training, which is not discussed in this study.)

In his retention model, Fagan found that married officers with children, older NFOs, USNA and NROTC graduates, and prior enlisted officers are more likely to be retained.[52] Furthermore, he found that female officers, single officers with no dependents, SNFOs who attrite from training, OCS graduates, and Maritime NFOs are less likely to stay until the LCDR (O-4) promotion point. Unfortunately, he did not use graduate education as a variable in the retention model.

In his promotion model, Fagan found that graduate education has no significant effect on promotion to LCDR. He explained this result by suggesting that the primary determining factor in promotion to LCDR is not a graduate education, but rather, the officer's performance during the first sea tour. Moreover, he found that younger (less

[52] Billy K.Fagan, "Analysis Of Determinants Of Training Performance, Retention, And Promotion To Lieutenant Commander Of Naval Flight Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2002)

than 23 years old at the time of commissioning) married officers with or without children, USNA and OCS graduates, NROTC graduates from less selective schools, and those who complete NFO training the fastest are more likely to be promoted.[53]

6. Study by Kabalar (2003)

In his thesis, "Multivariate Analysis of the Effect of Graduate Education on Promotion to Army Lieutenant Colonel," Hakan Kabalar estimated the effect of graduate education and other factors on promotion to lieutenant colonel (O-5) in the Army. His focus was primarily on determining whether graduate education provided officers with higher promotion probabilities.[54]

Kabalar used the Active Duty Military Master File Data, provided by Defense Manpower Data Center, for fiscal years 1981 to 2001 in his analysis. He used only the first three cohort data sets (1981, 1982, and 1983) for the study. The 1981 cohort had 2,653 observations, the 1982 cohort had 2,274 observations, and the 1983 cohort had 1,907 observations.[55] To prevent any bias from early resignations, only officers who reached the rank of O-3 were selected for the analysis.[56]

The dependent variable in Kabalar's study was PROMOTED, which was equal to one if an officer was promoted to O-5, and equal to zero if an officer was not promoted to O-5. The explanatory variables were gender, race, marital status, number of dependents, education, commissioning source, career path, prior enlisted situation and age. He defined his education variable using two groups. The first group consisted of those with a baccalaureate degree or lower level. The second group held a master's or a first professional degree, which he identified as graduate degrees. Kabalar used logistic regression and classification tree models in his study. He used a logistic regression model

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[53] Fagan, 69.

[54] Hakan Kabalar, **"**Multivariate Analysis of the Effect of Graduate Education on Promotion to Army Lieutenant Colonel," (Master's Thesis., Naval Postgraduate School, Monterey, California, 2003)

[55] Ibid, 20.

[56] Ibid, 19.

because the outcome variable in logistic regression is binary or dichotomous.[57] The reason for using a classification tree model was that tree-based modeling is an exploratory technique for uncovering structure in data.

Kabalar found that graduate education is associated with a higher probability of promotion to the rank of Army O-5.[58] The promotion ratio among officers with graduate degrees was 1.79-2.25 times the same ratio for officers without a graduate degree. His other findings were as follows:

- Academy or ROTC/NROTC SCHOLARSHIP graduates and married officers had greater odds ratios for officer promotion compared to direct appointment commissioned officers and single officers.
- Age had a negative effect on promotion.
- Number of dependents, DOD primary occupation code, gender, and prior enlisted situation had no significant effect on promotion.

7. Study by Kizilkaya (2004)

In his master's thesis, "An Analysis of the Effect of Commissioning Sources on Retention and Promotion of U.S. Army Officers," Zafer Kizilkaya used education level as an explanatory variable in a promotion to O-5 model. The main purpose of this thesis was to analyze the effect of commissioning sources on the retention and promotion of Army officers.

Kizilkaya used a data set obtained from the Active Duty Military Master File, provided by Defense Manpower Data Center. This data set included officers who were commissioned between 1981 and 2001. In his retention model, there were 32,054 observations; in his Promotion to O-4 model there were 25,740 observations; and in his promotion to O-5 model, there were 4,211 observations used for analysis. When selecting the variables for his analysis, he chose the variables used by Kabalar (2001). Those dependent and independent variables are shown in tables 3 and 4.

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[57] Kabalar, 20-21.

[58] Ibid, 43.

Table 3. Dependent variables in Kizilkaya's Study

RETAINED	0 IF THE OFFICER HAS A BLANK PAY GRADE AT 10 YEAR MARK
	0 IF THE OFFICER A PAY GRADE AT 10 YEAR MARK
PROMOTED.O4	0 IF THE OFFICER IS NOT PROMOTED TO O-4
	1 IF THE OFFICER IS PROMOTED TO O-4
PROMOTED.05	0 IF THE OFFICER IS NOT PROMOTED TO O-5
	1 IF THE OFFICER IS PROMOTED TO O-5

Source: From Zafer Kizilkaya, "An Analysis of the Effect of Commissioning Sources on Retention and Promotion of U.S. Army Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2004)

Kizilkaya did not use education as an explanatory variable in the promotion and retention to the rank of Major models. He explained that the reason for not including an education variable in those models was that most Army officers are selected for graduate schools only after finishing the Captains' Career Course and serving as company commanders, so most would not have completed graduate education by the time they reached the rank of O-4. In Kizilkaya's study, only models for promotion to O-5 included education as an explanatory variable.

In his promotion to O-5 models, Kizilkaya used PROMOTED as a dependent variable, which was equal to one if an officer was promoted to O-5, and zero if an officer was not promoted to O-5. His explanatory variables were education level, marital status interacted with number of dependents, age at commissioning, race, prior enlisted situation and commissioning source.

Table 4. The Independent Variables in Kizilkaya's Study

DEMOGRAPHICS	
GENDER	1 IF MALE
	2 IF FEMALE
RACE	0 UNKNOWN
	1 IF WHITE
	2 IF AFRICAN AMERICAN
	3 IF OTHER
MARITALSTAT.O3	1 IF THE OFFICER IS SINGLE
MARITALSTAT.O4	2 IF THE OFFICER IS MARRIED
	3 IF THE OFFICER IS NO LONGER MARRIED
NUMDEPEND.O3	1 IF OFFICER ONLY AND 0 DEPENDENT
NUMDEPEND.O4	2 IF THE OFFICER AND 1 DEPENDENT
	3 IF THE OFFICER AND 2 DEPENDENTS
	4 IF THE OFFICER AND 3 DEPENDENTS
	5 IF THE OFFICER AND FOUR OR MORE DEPENDENTS
AGE	AGE AT COMMISSIONING
PROFESSIONAL AND EDUCATIONAL TRAITS	
EDUCATION	1 IF THE OFFICER HAS A BACCALAUREATE OR LOWER
	2 IF THE OFFICER HAS A MASTER'S OR HIGHER DEGREE
COMMSOURCE	1 IF THE OFFICER IS AN ACADEMY GRADUATE
	2 IF THE OFFICER IS COMMISSIONED THROUGH ROTC
	3 IF THE OFFICER IS COMMISSIONED THROUGH OCS
	4 IF THE OFFICER IS COMMISSIONED BY DIRECT APPOINTMENT
DPOG	0 IF UNKNOWN
	1 IF TACTICAL OPERATIONS OFFICER
	2 IF INTELLIGENCE OFFICER
	3 IF ENGINEERING AND MAINTENANCE OFFICER
	4 IF HEALTH CARE OFFICERS
	5 IF ADMINISTRATORS
	6 IF SUPPLY, PROCUREMENT AND ALLIED OFFICER
PE	0 IF THE OFFICER IS NOT PRIOR ELISTED
	1 IF THE OFFICER IS PRIOR ENLISTED

Source: From Zafer Kizilkaya, "An Analysis of the Effect of Commissioning Sources on Retention and Promotion of U.S. Army Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2004)

Kizilkaya found that officers with graduate education were between 1.65 and 2.17 times more likely to be promoted to O-5 (Lieutenant Colonel) than officers who did not have graduate degree. His other findings included the following:

- Academy graduates were more likely to be promoted to Lieutenant Colonel than ROTC graduates and Direct Appointments. Direct Appointments had the lowest predicted promotion to Lieutenant Colonel.
- Being married and not being prior enlisted positively affected promotion to Lieutenant Colonel.
- Gender had no effect on promotion to Army Lieutenant Colonel.

8. Study by Korkmaz (2005)

In his Masters' thesis, "Analysis of the Survival Patterns of United States Naval Officers," Ibrahim Korkmaz evaluated the factors that affect the longevity of officers in the U.S. Navy. Although his focus in the study was commissioning source of officers, one of the variables in his survival model was the graduate education situation of an officer. Thus, in his study, he mentioned the effect of graduate education on the survival of United States naval officers.

For his survival analysis, Korkmaz obtained data from Prof. William R. Bowman, Economics Department, U.S. Naval Academy. The data contained Navy Officer Data Card Information for 34,991 officers commissioned from 1983 to 1990. Prof. Bowman merged the Data Card files with O-3 (LT) and O-4 (LCDR) promotion board results for fiscal years 1986 through 2001. The data set was checked to determine whether officers left the service before the LT and LCDR points.[59]

Korkmaz used Survival Analysis techniques in his analysis. He used the LIFETEST, LIFEREG, and PHREG procedures in the SAS software system as survival techniques.

[59] Ibrahim Korkmaz, "Analysis of the Survival Patterns of United States Naval Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2005), 67.

His dependent variable in the analysis was SERVTIME (months served before leaving the service). He classified explanatory variables into five categories as follows:

- Demographics (age at commissioning, race, gender, marital status with or without children);
- Commissioning sources;
- Community designators (Military Occupational Specialty);
- Career characteristics (prior enlisted situation of an officer); and
- Human capital variables (such as education level, college GPA, technical major in college and graduate education).

Furthermore, he used fiscal year as a control variable. This set of variables showed the year in which an officer was commissioned as an O-1.

According to his Duration Analysis (LIFEREG) procedure results, graduate education had no significant effect on the survival of officers. Korkmaz used Cox Proportional Hazards regression (PHREG) to analyze three different models - all separations, involuntary separations and voluntary separations. In his Cox Proportional Hazards regression (PHREG) analysis results, graduate education had a significant effect on the separation behavior of officers only in the involuntary separations model.

9. Study by Doganca (2006)

In his master's thesis, "Officer Career Paths and the Effects of Commissioning Sources on the Survival Patterns of Army Officers", Erkan Doganca analyzed the career paths of U.S. Army officers and evaluated the effect of commissioning source on their survival patterns.[60] He also analyzed the effect of graduate education on the survival of U.S. Army officers.

Doganca obtained the data for his analysis from the Active Duty Military Master File provided by the Defense Manpower Data Center (DMDC). The data set contained information about 103,501 Army officers who were commissioned between 1981 and 2001.

[60] Erkan Doganca, "Officer Career Paths and the Effects of Commissioning Sources on the Survival Patterns of Army Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2006).

He used N_ARMY (number of years a valid paygrade appears) as the dependent variable in his analysis. SEPARATE was his censoring variable which was equal to one if an officer separated from the service, and equal to zero if an officer did not separate. He defined independent variables in six different groups as follows:

- Demographic Characteristics (age, race, gender, family status)
- Commissioning Source
- Occupation Codes (Occupation Categories)
- Career Characteristics (prior enlisted situation)
- Education (whether or not an officer graduated from any graduate education program)
- Cohort Year (from 1981 to 2001)

Like Korkmaz, Doganca used survival analysis for his study. He used the LIFETEST, LIFEREG and PHREG SAS software procedures. He found that graduate education had a significant positive effect on survival of Army officers; that is, officers with graduate degrees served longer than those without graduate degrees in the results of both LIFEREG and PHREG procedures. Other important findings in the study are as follows:

- Although entry age and prior enlisted situation had no significant effect on the survival of Army officers in the LIFEREG procedure, they had positive effects in the PHREG model.
- Being Hispanic had no effect on the survival in the results for both methods (LIFEREG and PHREG).
- Being black, married and having more dependents had positive effects on the retention of Army officers.
- Being female had a negative impact on the survival behavior of Army officers.

C. CHAPTER SUMMARY

Although Fagan found that graduate education had no significant effect on promotion of Naval Flight Officers, Buterbaugh found different results (positive or

negative effects for different Navy communities) and Korkmaz found that graduate education had no significant effect on retention of Army officers, all other studies summarized in this chapter concluded that advanced education had a positive effect on retention and promotion; that is, it increases the probability of staying in the Army longer, and it increases the probability of being promoted to the O-4, O-5 or O-6 grades. The independent variables other than graduate education varied among the studies. For example, some studies included performance measures such as fitness reports as an independent variable, while others did not. The next chapter explains variable selection and description for this study.

None of the previous studies classified graduate education or advanced education as master's, doctorate and professional degrees, which is unique to this study. Classifying advanced education into those categories provides an opportunity to compare the effects of different graduate education levels on retention and promotion.

IV. METHODOLOGY

This thesis uses survival analysis as an empirical method for estimating both promotion probabilities and retention behavior of U.S. Army officers. Although many studies have used survival analysis to analyze retention behavior, using survival analysis for promotion models is not so pervasive.

This chapter explains the methodology used for this study and specifies hypothesized effects of selected explanatory variables on the retention and promotion of U.S. Army officers. It first briefly describes survival analysis. This is followed by an explanation of the variables used for the study and a discussion of the hypothesized effects of explanatory variables.

A. SURVIVAL ANALYSIS

Although survival analysis was first used to study the occurrence of deaths, today it is used in many fields of science, economics, and social sciences. Some examples of events that are studied using survival analysis include machine failures, promotion, retention and survival in any organization. The interpretation of coefficients of covariates in survival analysis, especially for promotion models, can be somewhat arduous. Explaining promotion of a group of people is difficult, since survival analysis is usually based on death, which is the opposite type of event from promotion. Nevertheless, if the main idea is captured, it is possible to interpret the effect of covariates on promotion probabilities.

Survival analysis is a class of statistical methods for studying the occurrence and timing of events.[61] *Event* is defined as a change in the general situation or transition from one situation to another, such as promotion and separation, as they are used in this study. This thesis examines the following events: occurrence of promotion of U.S. Army officers to MAJOR rank (O-4 grade), staying in the Army, and leaving the Army.

[61] Paul D.Allison, *Survival Analysis Using the SAS System,* (North Carolina: SAS Publishing, 2003), 1.

The timing of events is also part of survival analysis. So, the time of promotion and separation must also be known, in addition to whether or not the event occurred. Thus, in survival analysis, subjects are observed during some time frame and occurrence and timing of events or changes are recorded. This study observes officers who were commissioned from 1981 to 2001, and the occurrence of promotion or separation is examined from 1981 to the year they leave the Army, or to 2004, which is the last year the officers are tracked.

1. The Reason for Using Survival Analysis

Survival data have two common features that are difficult to handle with conventional statistical methods: censoring and time-dependent covariates.[62] Conventional statistical methods can estimate the occurrence of an event but cannot observe when the event occurred. For example, in a promotion model, one might put a ten year time limit on the occurrence of promotion and estimate promotion probability at the end of ten years. But, what about the officers who were promoted in less than ten years? They will also have a value of one (promoted), just the same as the other officers who were promoted at the end of the ten year period. In LOGIT or PROBIT models, the characteristics of officers who were promoted earlier will have the same importance for the outcome of the model as the characteristics of those who were promoted later. This might be overcome in those models by using dummy variables for time periods. But, if there are many time periods considered, say weeks over three years, then the model would need 156 dummy variables. There are too many dummy variables to adequately interpret a situation such as this.

Because survival analysis analyzes the timing of the event, the characteristics of officers who were promoted earlier will be more effective in survival analysis, since both probability of promotion and time of promotion is important in survival analysis. In addition, all methods of survival analysis allow for censoring (discussed below) and many also allow for time-dependent covariates.[63]

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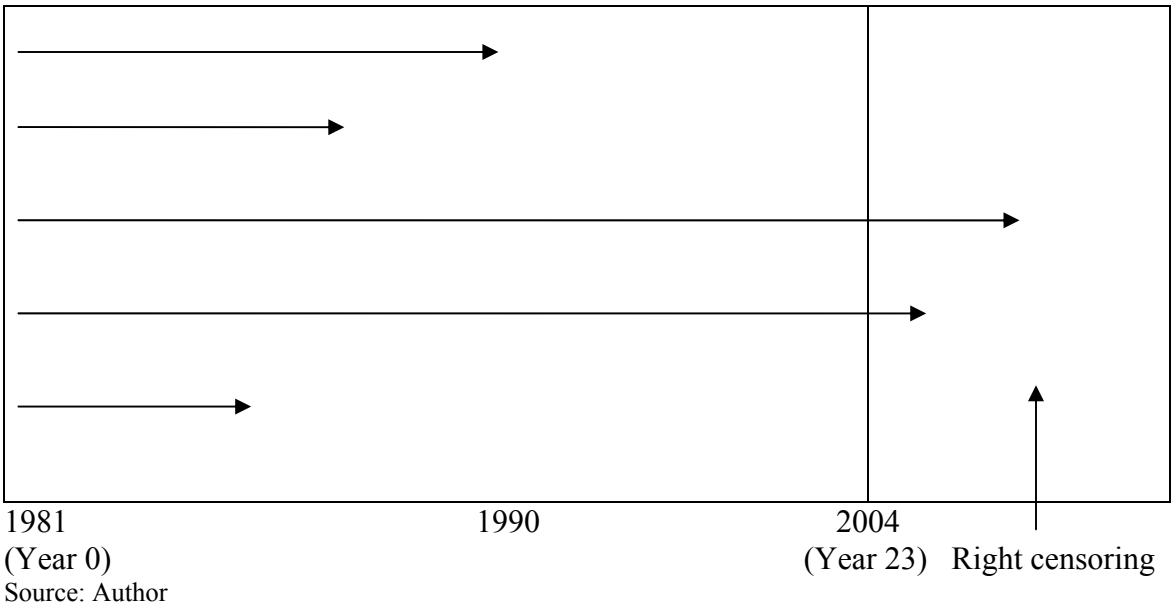
[62] Allison, 4

[63] Allison, 5

2. Censoring

If one observes the occurrence of an event from any time that the event can begin until a specific time, it is called right censored. The logic is that if, after this specific time, the occurrence of an event is not observed, the observation is then censored. Suppose that one observes five officers who were commissioned in 1981. The event is separation from the Army. Some of the officers (three of them) separate during the time period from 1981 to 2004, but some of them are still in the Army in 2004. One stops observing those officers in year 2004; therefore, it is unknown when they will separate. These officers' separation time is right censored, as shown in Figure 1.



Source: Author

Figure 1. Right Censoring

Left censoring is the opposite of right censoring. In left censoring, one begins observing events after their occurrence has begun. Thus, one does not observe the events that occurred before the time observation began, and they are therefore left censored.

There are three types of censoring according to their implementation: Type-I, Type-II and random censoring. The censoring explained in Figure 1 is Type-I censoring. In type-I censoring, the observation of events is stopped after some time. In the above example, it is stopped in year 2004, after 23 years of observation.

In Type-II censoring, the observation is stopped after a number of events has occurred. Suppose that one is observing the same five officers who were commissioned in 1981. The event is promotion, rather than separation. Some of the officers have been promoted once, some have been promoted more than once, and some have never been promoted. Suppose that in this example one stops observing after two promotions have occurred. Thus, Type-I censoring can control the time, but Type-II censoring cannot control the time. One must wait until a specific number of events (in our example, it is two) occurs. So, in the example above, it is unknown at the beginning when two promotions are going to happen. Random censoring occurs when one has no control over the determination of when to stop observations. Random censoring can also happen when the entrance time of subjects differs, but the ending time of observations is fixed for everyone, whether the event has occurred or not. For example, in the separation example above, suppose that some of the officers were commissioned in different years (not all in 1981), and one observes all of them until 2004. The entry time of subjects is thus out of one's control in random sampling.

3. Survival Distribution Functions

The occurrence time of an event for an individual is a random variable that has a probability distribution. There are many different models for survival data, and what often distinguishes one model from another is the probability distribution.[64] There are three types of distribution functions that are relevant:

- Cumulative Distribution Function,
- Probability Density Function, and
- Hazard Function.

The Cumulative Distribution Function shows the probability that the variable will be less than or equal to any value chosen. Survival analysis uses the Survivor Function instead of the Cumulative Distribution Function. The Survivor Function shows the probability that an event will occur. The value of the Survivor Function never increases

[64] Allison, 14.

as time passes; instead, it decreases with time. The LIFETEST procedure, described below, examines this issue in greater detail. The Probability Density Function is just the slope of the Cumulative Density Function. Survival analysis uses this function more commonly than the Cumulative Density Function. Finally, the Hazard Function shows the probability of an event's occurrence at any time. The Survivor Function, the Probability Density Function and the Hazard Function are equivalent ways of describing a continuous probability distribution.[65]

This study uses three main procedures of survival analysis, using the SAS statistical software. They are the LIFETEST, LIFEREG and PHREG procedures.

4. The LIFETEST Procedure in SAS

The Proc LIFETEST procedure in SAS uses both the Kaplan-Meier method and the life-table method in order to find estimates of survivor functions. Both methods give the probability that a person will survive (stay or promote) until the time $t+1$, given that he or she has survived until the time t. It also shows the probability of not surviving (separate or not promote) during the same time frame. After time $t+1$ they are censored, because the results are unknown. The difference is that the Kaplan-Meier method gives probabilities for every observation in the sample, which is not suitable for a large data set, whereas the life-table method gives results by grouping observations based on the time differences, which is appropriate for large data sets. Since the data set is too large in this analysis, only the life-table method is used. Moreover, the life-table method produces estimates and plots of the hazard function.[66]

The LIFETEST procedure also tests whether the survivor functions of different groups are the same or not. This study examines the survivor functions of officers with different education levels. For this test, PROC LIFETEST calculates two alternative statistics for testing this difference - the long-rank test and the Wilcoxon test.[67] The likelihood ratio test is the third method for testing differences in survival functions that

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[65] Allison, 16.

[66] Ibid., 41

[67] Ibid., 36.

the LIFETEST Procedure provides. This last test assumes that the event times have an exponential distribution. The LIFETEST procedure in SAS gives the p-values for these three tests.

The LIFETEST procedure in SAS is useful for preliminary analysis of data. It also produces survivor function and hazard function graphs for different groups on the same figure for comparison. These graphs give some preliminary ideas about the survivor and hazard functions of different groups.

5. The LIFEREG Procedure in SAS

The LIFEREG Procedure produces estimates of parametric regression models with censored survival data using the method of maximum likelihood.[68] PROC PHREG, which uses a partial likelihood method for doing semi-parametric regression analysis, has recently become popular. However, PROC LIFEREG is superior to PROC PHREG in several ways:[69]

- PROC LIFEREG accommodates left censoring and interval censoring, while PROC PHREG allows only right censoring.
- PROC LIFEREG allows testing for hypotheses about the shape of the hazard function, while PROC PHREG provides only non-parametric estimates of the survivor function, which can be difficult to interpret.
- If the shape of the survival distribution is unknown, PROC LIFEREG produces more efficient estimates with smaller standard errors than PROC PHREG.
- PROC LIFEREG automatically creates sets of dummy variables to represent categorical variables with multiple values, whereas PROC PHREG requires creating such variables in a data step.

The biggest disadvantage of the LIFEREG procedure is that it is not capable of handling time dependent covariates, whereas the PHREG procedure can do this. On the

[68] Allison, 61.

[69] Ibid., 61,62.

other hand, the ability to handle left and right censoring, and its rich array of survival distributions are the two greatest advantages of PROC LIFEREG.

If the survival data had no censored values, the OLS regression and the LIFEREG Procedure in SAS with the log-normal distribution would give exactly the same results. The distributions used in LIFEREG are:

- The Weibull Distribution,
- The Exponential Distribution,
- The Gamma Distribution,
- The Log-logistic Distribution, and
- The Log-normal Distribution.

These distributions are named for the event time for each individual, rather than the distribution of error terms. The main reason for allowing five different types of models in PROC LIFEREG is that they have different implications for hazard functions that may, in turn, lead to different essential interpretations.[70]

6. The PHREG Procedure in SAS

PROC PHREG in SAS gives the Cox survival analysis results. It is the newest and most widely used survival model. The reason for its popularity is that it does not necessitate choosing some particular probability distribution to describe survival times. Other reasons include the following:[71]

- The Cox regression model makes it easier to fit time dependent parameters.
- The Cox regression model allows a kind of analysis that is very effective in controlling for nuisance variables.
- The Cox regression model makes it easy to adjust for periods of time in which an individual is not at risk of an event.

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[70] Allison, 66.

[71] Allison, 111, 112.

- The Cox regression model readily accommodates both discrete and continuous measurement of event times.

B. MODEL

The model used for this study is based on the studies described in Chapter III. Analysis of the decision to leave the Army or continue to serve is one of the main purposes of this study. Another purpose is to identify the factors affecting promotion to MAJOR rank (Grade 4). Based on previous studies, the candidate factors that affect the retention behavior and promotion to O-4 grade of US Army officers are chosen as follows:

- Education Level (College graduation, master's degree, doctorate graduation and professional degree)
- Gender
- Marital Status
- Entry Age
- Race-Ethnicity (White, Black, Hispanic, Other Race)
- Commissioning Source (United States Military Academy, Reserve Officers' Training Corps, Officer Candidate School, and Direct Commission Officer)
- Prior Enlistment Status
- Military Occupational Specialty (Special Branches, Combat Arms, Combat Support, Combat service support)
- Commissioning Year as an Officer (From 1981 to 2001).

The theoretical model can be written as follows for both the retention and promotion models:

$H_i(t) = \lambda_0(t)$*exp f (Educational Level, Entry Age, Race-Ethnicity, Commissioning Source, Marital Status, Gender, Prior Enlisted Status, Occupation Category, Entry Year).

The only difference between the models is the dependent (time + censoring) variables. For the retention model it will be the officer's staying status (whether an officer stayed until 2004) and time to separation, and for the promotion model it will be promotion status (whether an officer is promoted to O-4) and time to promotion.

C. VARIABLE DESCRIPTION

Two main variables are combined to create the dependent variable in survival analysis - duration and the censoring variable. Duration is a variable that shows how long it takes for an officer to leave the Army or how long it takes to be promoted to MAJOR. The duration variable in this study is called YEARSSERVED for the retention model and TIMEYRS for the promotion model.

The censoring variable for the retention model is STAY, which shows whether the officer stayed in the Army until 2004. For the promotion model the censoring variable is PROMO4, which shows whether an officer was promoted to MAJOR. Table 5 shows definitions of dependent, duration, and censoring variables. Table 6 shows definitions of the explanatory variables.

The variable definitions used in this study are based on Bowman and Mehay, and Doganca. Some of the variables were tracked yearly until 2004, such as educational level and marital status. For such variables in the retention model, the last observed value is used. In the promotion model, the value at the tenth year is used.

1. Education Variables

Educational level is the main explanatory variable in this study. Four binary variables are used to show the education level of Army officers in this thesis: college degree (COLLEGEDEGREE), master's degree (GRADUATEDEGREE), doctorate degree (DOCTORATEDEGREE), and first professional degree (PROFESSIONALDEGREE). College degree as used in this study is defined as a baccalaureate or four-year college degree.

Most of the previous studies found that advanced education has a positive effect on both retention and promotion. For the retention model, all education level data is for the last observed education level (at separation or in 2004, if still on active duty in 2004). For the promotion model, it is the observation at the promotion year if an officer is promoted to MAJOR rank. If an officer is not promoted to O-4 grade, then the education variable is the last observed value. COLLEGEDEGREE is the base case.

Table 5. Variable Definitions

VARIABLE	DEFINITION
DEPENDENT VARIABLES	
YEARSSERVED (RETENTION MODEL)	NUMBER OF YEARS A VALID PAYGRADE APPEARS
TIMEYRS (PROMOTION MODEL)	NUMBER OF YEARS TO BE PROMOTED TO O-4 FROM COMMISSIONING YEAR
CENSORING VARIABLES	
STAY (RETENTION MODEL)	= 1 IF STILL IN THE SERVICE
	= 0 IF LEFT THE SERVICE
PROMO4 (PROMOTION MODEL)	= 1 PROMOTED TO 0-4 GRADE (MAJOR)
	= 0 OTHERWISE
VARIABLE	**DEFINITION**
INDEPENDENT VARIABLES	
EDUCATION VARIABLES	
COLLEGEDEGREE	= 1 IF HAS COLLEGE DEGREE **(BASE CASE)**
	= 0 OTHERWISE
GRADUATEDEGREE	= 1 IF HAS MASTERS DEGREE
	= 0 OTHERWISE
DOCTORATEDEGREE	= 1 IF HAS DOCTORATE DEGREE
	= 0 OTHERWISE
PROFESSIONALDEGREE	= 1 IF HAS PROFESSIONAL DEGREE
	= 0 OTHERWISE
DEMOGRAPHIC VARIABLES	
	GENDER
FEMALE	= 1 IF FEMALE
	= 0 IF MALE **(BASE CASE)**
	MARITAL STATUS
MARRIED	= 1 IF MARRIED
	= 0 IF SINGLE **(BASE CASE)**
	ENTRY AGE
ENTRYAGE	AGE AT THE ENTRY TO THE ARMY
	RACE/ETHNICITY
WHITE	= 1 IF WHITE **(BASECASE)**
	= 0 OTHERWISE
BLACK	= 1 IF BLACK

VARIABLE	DEFINITION
	= 0 OTHERWISE
HISPANIC	= 1 IF HISPANIC
	= 0 OTHERWISE
OTHERRACE	= 1 IF OTHER RACE
	= 0 OTHERWISE
	COMMISIONING SORCE
ACADEMY	= 1 IF COMMISSIONING SOURCE IS USMA **(BASE CASE)**
	= 0 OTHERWISE
ROTCSCHOLAR	= 1 IF COMMISSIONING SOURCE IS ROTC SCHOLARSHIP
	= 0 OTHERWISE
ROTCNONSCHOLAR	= 1 IF COMMISSIONING SOURCE IS ROTC CONTRACT
	= 0 OTHERWISE
OTHERSOURCE	= 1 IF COMMISSIONING SOURCE IS OTHER THAN ACADEMY OR ROTC
	= 0 OTHERWISE
	PRIOR ENLISTMENT STATUS
PREENLIST	= 1 IF PRIOR ENLISTED
	= 0 OTHERWISE **(BASE CASE)**
	MILITARY OCCUPATIONAL SPECIALTY
COMBATARMS	= 1 IF IN COMBAT ARMS FIELD **(BASE CASE)**
	= 0 OTHERWISE
COMBATSUPPORT	= 1 IF IN COMBAT SUPPORT FIELD
	= 0 OTHERWISE
COMBATSERVICESUPPORT	= 1 IF IN COMBAT SERVICE SUPPORT FIELD
	= 0 OTHERWISE
SPECIALBRANCHES	= 1 IF IN SPECIAL BRANCHES FIELD
	= 0 OTHERWISE
COMMISSIONING	**YEARS (CONTROL VARIABLES)**
ENTRYYR81	= 1 IF COMMISSIONING YEAR IS 1981 **(BASE CASE)**
	= 0 OTHERWISE
ENTRYYR82	= 1 IF COMMISSIONING YEAR IS 1982
	= 0 OTHERWISE
ENTRYYR83	= 1 IF COMMISSIONING YEAR IS 1983
	= 0 OTHERWISE

VARIABLE	DEFINITION
ENTRYYR84	= 1 IF COMMISSIONING YEAR IS 1984
	= 0 OTHERWISE
ENTRYYR85	= 1 IF COMMISSIONING YEAR IS 1985
	= 0 OTHERWISE
ENTRYYR86	= 1 IF COMMISSIONING YEAR IS 1986
	= 0 OTHERWISE
ENTRYYR87	= 1 IF COMMISSIONING YEAR IS 1987
	= 0 OTHERWISE
ENTRYYR88	= 1 IF COMMISSIONING YEAR IS 1988
	= 0 OTHERWISE
ENTRYYR89	= 1 IF COMMISSIONING YEAR IS 1989
	= 0 OTHERWISE
ENTRYYR90	= 1 IF COMMISSIONING YEAR IS 1990
	= 0 OTHERWISE
ENTRYYR91	= 1 IF COMMISSIONING YEAR IS 1991
	= 0 OTHERWISE
ENTRYYR92	= 1 IF COMMISSIONING YEAR IS 1992
	= 0 OTHERWISE
ENTRYYR93	= 1 IF COMMISSIONING YEAR IS 1993
	= 0 OTHERWISE
ENTRYYR94	= 1 IF COMMISSIONING YEAR IS 1994
	= 0 OTHERWISE
ENTRYYR95	= 1 IF COMMISSIONING YEAR IS 1995
	= 0 OTHERWISE
ENTRYYR96	= 1 IF COMMISSIONING YEAR IS 1996
	= 0 OTHERWISE
ENTRYYR97	= 1 IF COMMISSIONING YEAR IS 1997
	= 0 OTHERWISE
ENTRYYR98	= 1 IF COMMISSIONING YEAR IS 1998
	= 0 OTHERWISE
ENTRYYR99	= 1 IF COMMISSIONING YEAR IS 1999
	= 0 OTHERWISE
ENTRYYR00	= 1 IF COMMISSIONING YEAR IS 2000
	= 0 OTHERWISE
ENTRYYR01	= 1 IF COMMISSIONING YEAR IS 2001
	= 0 OTHERWISE

Source: Author

Branigan (2001) stated that since an officer who spent his or her time getting a graduate degree would be away from his normal career path, and therefore would have received unobserved fitness reports, he or she might have been less likely to be promoted.[72] Furthermore, an officer who is away from work pursuing a graduate degree may not be able to obtain enough experience for a higher command level, which may also decrease his or her probability of being promoted to O-4. Moreover, the probability of finding a job in the civilian labor market increases with graduate education. Officers with professional degrees have specialized jobs, such as doctors or lawyers, which are much sought after in the civilian labor market, and which have high civilian earnings. On the other hand, an officer who attended graduate school instead of doing a daily job obtains new skills. Thus, advanced education might increase officers' abilities. In addition, officers owe service obligations when their education costs are paid by military. After serving more than ten years because of service obligations, officers might prefer continuing to serve until their retirements in order to obtain the benefits of retirement.

Although advanced education might have both negative and positive effects on retention and promotion, it is hypothesized that the advantages of graduate education for military life outweigh the disadvantages, and it is expected that advanced education will have a positive effect on both retention and promotion probabilities of Army officers. Literature supports this assumption. Buterbaugh (1995), Wielsma (1996), Bowman and Mehay (1998), Branigan (2001), and Kizilkaya (2004) all found that graduate education had a positive effect on promotion. In addition, Wielsma (1996), Branigan (2001), and Doganca (2006) found that graduate education had a positive effect on retention.

2. Demographic Variables

FEMALE is a gender variable which is equal to one if an officer is female and zero if male. Male is the base case. In the literature, there are instances of positive, negative and insignificant relationships between being female and retention or promotion. Buterbaugh (1995) found a negative relationship between being female and promotion to O-5 and no significant relationship between being female and promotion to O-6. Mehay

[72] Branigan, 34.

and Bowman (1998) and Branigan (2001) found that being female had a positive effect on promotion. Wielsma (1996), Kabalar (2003) and Kizilkaya (2004) found no significant relationship between being female and promotion. Fagan (2002) and Doganca (2006) found that females are less likely to be retained in the military than males.

According to Wielsma (1996), women would be more likely to stay in the military, if they were not as responsible for child care.[73] Browman and Mehay mentioned that women in the Navy had been prevented from line duties, which keeps them from acquiring the best firm-specific skills.[74] Military personnel change duty location frequently, which might not be suitable for women and may cause women to stay in the Army for a shorter time. Finally, because of career interruptions due to family reasons, such as giving birth, childcare, home care, and husband's job location (if husband is not in the military), female officers are hypothesized to survive a shorter time than male officers and are assumed to be less likely to be promoted to grade O-4.

The variable MARRIED shows the marital status of an officer, which is a variable tracked yearly in the dataset. Thus, it has different definitions for the two models. For the retention model, it is equal to one if the last observed value is equal to MARRIED, and zero if single (single, divorced or widowed). For the promotion model, it is equal to one if an officer is married at the time of promotion, or if not promoted to O-4, then if the officer married at the last observed time, and zero otherwise. Single is the base case. Almost all of the studies mentioned in this thesis found a positive relationship between being married and retention and promotion.

Wielsma (1996) mentions in his thesis that marriage is a life-cycle decision. It could thus be hypothesized that if an officer was ready for marriage, that officer might be ready for some other life-cycle decisions, such as remaining in the Army and having the advantages of military life.[75] According to Branigan (2001), married officers are more likely to remain in the Marine Corps because of job security, and they are more motivated

[73] Wielsma, 27.

[74] Bowman and Mehay, 456.

[75] Wielsma, 28.

than single officers to perform well. Furthermore, marriage might increase productivity because married people have more stable lives. Finally, married officers have responsibilities to their families . Thus, being married is hypothesized to increase the probability of staying longer in the Army and being promoted to O-4.

ENTRYAGE is a continuous variable that shows the age of an officer at entry into the Armed Forces. In the literature, both positive and negative relationships are found between age and promotion or retention. According to Wielsma, the older an individual is, the more likely he or she is to stay in the same job.[76] According to Branigan (2001),[77] older officers at commissioning time might be more productive because of their maturity, but younger officers may have a stronger taste for the military because of their earlier entry to the military.[78] Finally, as age increases, people hope for a more stable life and they find the job that best matches their characteristics and expectations. It is hypothesized that officers whose ages at entry are older will stay longer and be more likely to be promoted to O-4.

There are four race/ethnicity variables in this study, WHITE, BLACK, HISPANIC and OTHERRACE. Each one of these variables takes a value of one according to the officer's race/ethnicity. WHITE is the base case. The variable OTHERRACE shows any other race/ethnicity than WHITE, BLACK or HISPANIC. The base case is WHITE. According to Fagan, it should be expected that racial differences will have no significant effect on the retention and promotion of Army officers, because of the equality of opportunity in the military. However, Doganca (2006) hypothesizes that minorities should be expected to stay longer than Whites because of the more equal pay and education opportunities available in the military compared with the civilian sector.[79] Because there is discrimination against minorities in the civilian sector, those officers are expected to stay longer in the Army, an organization in which there is less discrimination.

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[76] Wielsma, 26.

[77] Branigan, 41.

[78] Billy K. Fagan, "Analysis Of Determinants Of Training Performance, Retention, And Promotion To Lieutenant Commander Of Naval Flight Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2002), 37,38.

[79] Doganca, 68.

Furthermore, Blacks and other minorities might expect to be promoted to higher ranks in accordance with their performance levels in the military, because of the greater equality. In this thesis, Whites are expected to separate earlier than minorities, since they can find jobs more easily and have greater carrier opportunities in the civilian labor market. Finally, it is hypothesized that whites are more likely to be promoted. The literature supports this idea: Mehay and Bowman, as well as Buterbaugh found that being white has a positive effect on promotion.

3. Commissioning Source Variables

Four commissioning source variables are used in this study: United States Military Academy (ACADEMY), Reserve Officers' Training Corps (student uses scholarship) (ROTCSCHOLAR), Reserve Officers' Training Corps (no scholarship) (ROTCNONSCHOLAR), and sources other than those three (OTHERSOURCE), such as officer candidate school. ACADEMY is the base case. In the literature, almost all of the studies found that being a Military Academy graduate had a positive effect on both retention and promotion. Army ROTC trains individuals and provides them experiences they need to become Officers in the U.S. Army.[80] It is an elective college curriculum for college students and taken with some other courses.[81] Students enrolled in this curriculum at universities may do so by using Army scholarships. If they use scholarships, they have to serve fulltime for at least three years in the Army.[82]

Wielsma mentions that an officer who obtains his or her college degree from a military institution and who teaches military skills would be more experienced in his or her duties. Thus, these officers might more likely be promoted.[83] According to Mehay and Bowman, military academy students' four-year attendance at a military school

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[80] The United States Army Webpage, "Army ROTC", <http://www.goarmy.com/rotc/index.jsp>, (accessed January 15, 2007).

[81] The United States Army Webpage, "Army ROTC", <http://www.goarmy.com/rotc/about_army_index.jsp>, (accessed January 15, 2007).

[82] The United States Army Webpage, "Army ROTC", <http://www.goarmy.com/rotc>, (accessed January 15, 2007).

[83] Wielsma, 23.

increases their ability to assimilate into the military's team production environment.[84] Following graduation, they may be able to adapt to the military job environment as an officer more rapidly and easily. Branigan states that U.S. Naval academy and ROTC graduates begin taking military firm-specific training during their college years.[85] According to Fagan, since USNA graduates attend college in order to serve as naval officers for their country, they become familiar with Navy core values for four years, and thus they are more likely to stay and be promoted.[86] Finally, the graduates of USNA undertake a difficult education and training program during their academy years. This might be a kind of screening for those officers. Graduating from such a difficult school might show that they have dedicated themselves to the military life. For these reasons, in this study it is hypothesized that USMA graduates have the greatest probability of staying in the Army and being promoted to O-4.

4. Prior Enlistment Status Variable

PREENLIST is a variable that shows the officer's prior enlisted situation. It takes on a value of one if an officer served as an enlisted member before being commissioned as an officer, and zero otherwise. Officers who were not enlisted before being commissioned as an officer are the base case. According to Branigan (2001), officers who were enlisted serve four more years in order to get firm-specific training.[87] According to Fagan (2002), enlisted personnel get recommendations from their supervisors for acceptance into one of the accession pipelines, which shows that the enlistee is hard-working and determined.[88] Korkmaz (2005) states that since prior enlisted officers have already adapted to military life, they are more likely to stay longer in the Army.[89] Finally, prior enlisted officers choose to become officers voluntarily after

[84] Bowman and Mehay, 456.

[85] Branigan, 38.

[86] Fagan, 42.

[87] Branigan, 38.

[88] Fagan, 42.

[89] Korkmaz, 65.

their experience in the Army for several years. In this study, it is expected that prior enlisted officers remain in the Army longer and are more likely to be promoted to O-4.

5. Military Occupational Specialty Variables

There are four Military Occupational Categories used for the analysis in this thesis: Combat Arms Field (COMBATARMS), Combat Support Field (COMBATSUPPORT), Combat Service Support (COMBATSERVICESUPPORT), and Special Branches (SPECIALBRANCHES). Each of these variables takes a value of one if an officer serves in that field, and zero otherwise. The base case is COMBATARMS.

The variables above are Career Branch Categories. In Department of the Army Pamphlet 600-3, *Commissioned Officer Development and Career Management*, it is stated that "A branch is a grouping of officers that comprises an arm or service of the Army in which, as a minimum, officers are commissioned, assigned, developed and promoted through their company grade years."[90] According to the same Army Pamphlet, the branch categories in the Army are:[91]

- Combat arms branches (Infantry, Armor, Field Artillery, Air Defense Artillery, Aviation, Special Forces and Corps of Engineers);
- The combat support branches (Signal Corps, Military Police Corps, Military Intelligence Corps, Civil Affairs and Chemical Corps);
- The combat service support branches (Adjutant General Corps, Finance Corps, Transportation Corps, Ordnance Corps and Quartermaster Corps); and
- The special branches (The Judge Advocate General's Corps, Chaplain Corps, Medical Corps, Dental Corps, Veterinary Corps, Army Medical Specialists, Army Nurse Corps and Medical Service Corps).

Combat arms field officers are hypothesized to remain in the Army longer since they have more firm-specific training than officers in other categories. Furthermore, combat arms officers have a lower probability of finding better civilian jobs because the

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[90] *Department of the Army Pamphlet 600-3, Commissioned Officer Development and Career Management,* (Washington, DC: Headquarters Department of the Army, 2005), 68.

[91] Ibid., 68,69

abilities they acquire in the military are less likely to be applicable in civilian jobs. In addition, they are expected to be more likely to be promoted to O-4, because of their firm-specific education levels and abilities.

6. Commissioning Years (Control Variables)

In order to control for trends in retention and promotion over time, commissioning year is used as a control variable.[92] Commissioning year shows the year in which an officer began service as an officer, from 1981 to 2001. ENTRYYR81 is the base case.

D. CHAPTER SUMMARY

Survival analysis is used as an empirical analysis method for this study. *Survival analysis* is a class of statistical methods for studying the occurrence and timing of events.[93] The reason for using *survival analysis* is to analyze the timing of the event (promotion and retention). Thus, the characteristics of people who were promoted earlier will be more effective in survival analysis. The three main SAS Procedures used are LIFETEST, LIFEREG, and PHREG.

Two main variables are combined to create the dependent variable in survival analysis - duration and the censoring variable. The duration variable for the retention model is YEARSSERVED, which shows how long it takes an officer to leave the Army. It is TIMEYRS for the promotion model, which shows how long it takes to be promoted to MAJOR. There are two censoring variables: STAY for the retention model (whether an officer stayed in the army until 2004), and PROMO4 (whether an officer was promoted to MAJOR rank).

The main focus of this thesis is the effect of education level on retention and promotion. It is hypothesized that master's, doctorate and professional degrees all have positive effects on both retention and promotion. Hypothesized effects for all of the explanatory variables in the models are summarized in Table.6.

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[92] Doganca, 72.

[93] Allison, 1.

Table 6. Hypothesized Effects of Independent Variables

VARIABLE	RETENTION MODEL	PROMOTION MODEL
	EDUCATION	**VARIABLES**
COLLEGEDEGREE	**BASE**	**BASE**
GRADUATEDEGREE	+	+
DOCTORATEDEGREE	+	+
PROFESSIONALDEGREE	+	+
	DEMOGRAPHIC	**VARIABLES**
FEMALE	-	-
MARRIED	+	+
ENTRYAGE	+	+
WHITE	**BASE**	**BASE**
BLACK	+	-
HISPANIC	+	-
OTHERRACE	+	-
	COMMISIONING	**SORCE**
ACADEMY	**BASE**	**BASE**
ROTCSCHOLAR	-	-
ROTCNONSCHOLAR	-	-
OTHERSOURCE	-	-
	PRIOR ENLISTED	**STATUS**
PREENLIST	+	+
MILITARY	**OCCUPATIONAL**	**SPECIALTY**
COMBATARMS	**BASE**	**BASE**
COMBATSUPPORT	-	-
COMBATSERVICESUPPORT	-	-
SPECIALBRANCHES	-	-

Source: Author

V. DATA AND PRELIMINARY DATA ANALYSIS

This chapter describes the data set used for the analysis and presents the preliminary data analysis. It first explains the source of the data and then defines the data elements. Descriptive statistics are presented in two subsections. One subsection discusses retention statistics and one addresses promotion statistics. The reason for having two different subsections of statistics is that there are some differences in characteristics of samples used for retention and promotion analysis. Finally, this chapter addresses limitations of the data.

A. DATA

The data set used for this thesis is created from the Active Duty Military Master File, which is provided by the Defense Manpower Data Center. The data provide information about cohorts of Army officers who were commissioned between 1981 and 2001. Although the data set includes information on more than 100,000 officers, only 45,228 observations are used for retention analysis, and 12,092 for promotion analysis. This is because of missing and unknown values in some of the data fields.

Since each officer must hold at least a baccalaureate degree,[94] those observations that contained incorrect education level information (e.g., observations showing that officer's education level is less than a college degree) were deleted. While forming the data set, it also became clear that some of the observations did not contain valid pay grade progression information. Those officers with incomplete data for pay grade were also deleted from the analysis.

The variables for gender, age at entry, race/ethnicity, commissioning source, prior enlisted status and military occupational specialty are constant for each individual and do not change over time. However, the variables for education level and marital status change yearly, and those variables are therefore tracked yearly from the person's entry into the Army until the separation year or, if he or she did not leave the Army, until 2004.

94 *Army Regulation 135–155 Promotion of Commissioned Officers and Warrant Officers Other Than General Officers* (Washington DC, Headquarters, Department of the Army, 13 July 2004), 4.

Retention analysis uses the last observed value for those variables. Promotion analysis uses the value at promotion date if an officer is promoted to MAJOR (O-4). However, if the officer is not promoted to O-4, then the last observed value is used. (Note: Officers who are not promoted to O-4 are censored in the survival analysis.)

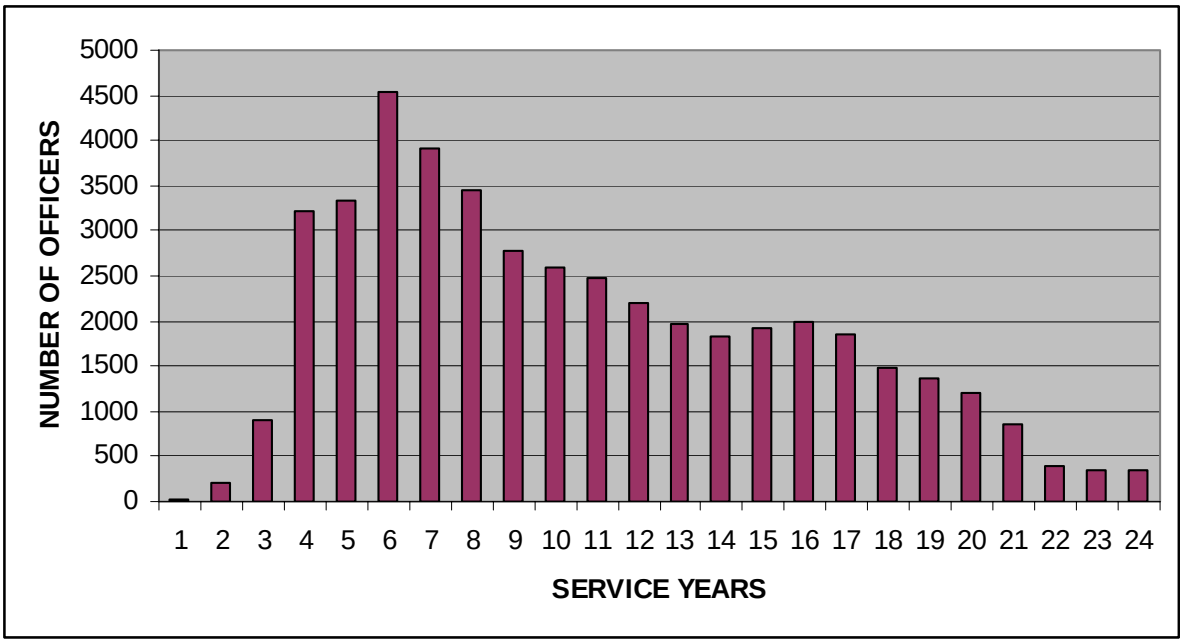
B. PRELIMINARY DATA ANALYSIS

1. Retention

All characteristic distribution and retention rates by the independent variables are summarized on the table in Appendix A. The table presents all independent variables, their distribution among officers, separation and continuation rates according to the explanatory variable, both in numbers and percentages.

YEARSSERVED is the duration variable for the retention model. It shows time of service in years. Service years show how many years an officer served until separation. Service years are measured from the commissioning year until separation for those who left the Army before September 30, 2004. For those who were still on active duty on that date, it is measured from the commissioning year to September 30, 2004. Figure 2 shows the number of officers by service years. As seen in the figure, the biggest group is the officers who serve six years. Officers with seven years service time are the second biggest group.

The censoring variable for the retention model is STAY. Officers who were still on active duty on September 30, 2004 were censored, their separation time or service time is unknown.



Source: Author tabulations based on DMDC data

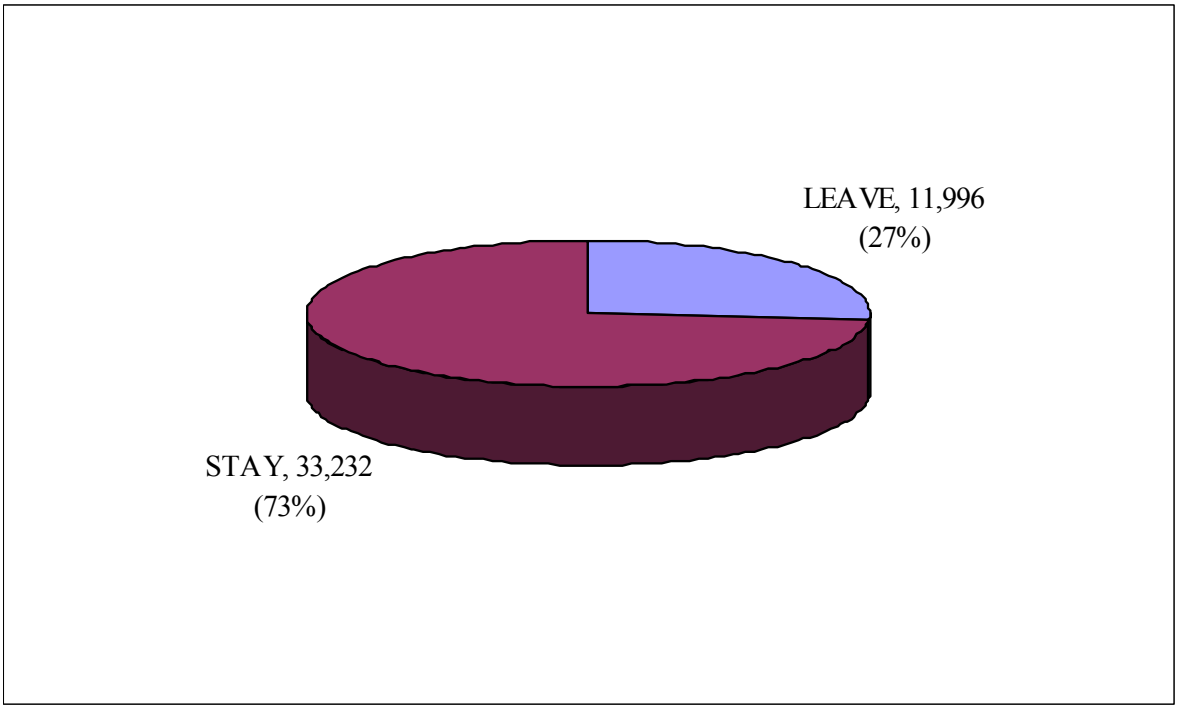
Figure 2. Number of Officers by Service Years

Figure 3 shows the number and percentage of officers in the data set who left the Army before 2004, as well as the number who were still on active duty in 2004. Of 45,228 officers used for the analysis, 33,232 (73 percent) were still on active duty on September 30, 2004, and 11,996 (27 percent) had left the Army by that date. However, because of the nature of the survival analysis, officers who were still in the Army in 2004 were censored and there is no information about their separation dates. The observation of officers' retention behavior stops in 2004. Furthermore, these figures do not indicate a retention decision on the part of all officers. Those who entered in the early cohort years would have been forced to retire, while those who entered in the last years would not have been able to leave, since they were still serving their obligated service period. The potential influence of the censored data means no precise conclusions can be drawn[95] from the numbers shown in these tables and figures.

As explained in Chapter III, the LIFETEST procedure in SAS is useful for preliminary analysis of data. It produces survivor function and hazard function graphs for

[95] Phillip Hoglin, "Survival Analysis and Accession Optimization of Prior Enlisted United States Marine Corps Officers," (Master's Thesis, Naval Postgraduate School, Monterey, CA, 2004), 35.

all officers on one figure, and for different groups on the same figure for comparison.[96] These graphs give some preliminary ideas about the survivor and hazard functions of different groups. Chapter VI examines survivor times and separation times in a more detailed preliminary analysis using the LIFETEST procedure.

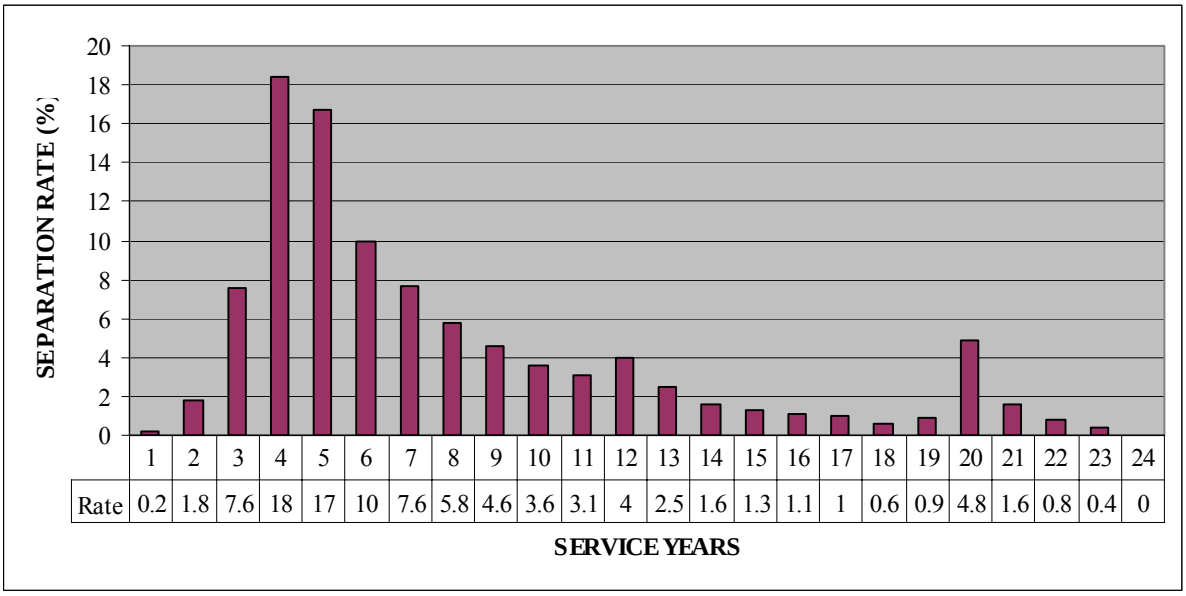


Source: Author tabulations based on DMDC data

Figure 3. Number and Percentage of Officers Entering the Army between 1981-2004 Who Had Separated by September 30, 2004

Figure 4 shows separation rate by years of service. The largest percentage of separations are in years 4 (18.36 percent) and 5 (16.73 percent). The reason for this is that the end of service obligation usually occurs in the fourth or fifth year, depending on the commissioning program. After the fifth year, the separation rate decreases until the twentieth year. There is an increase in separation rates at year 20 (4.83 percent), because officers are typically eligible for retirement.

[96] Paul D.Allison, *Survival Analysis Using the SAS System,* (SAS Publishing, North Carolina, 2003)29-60.

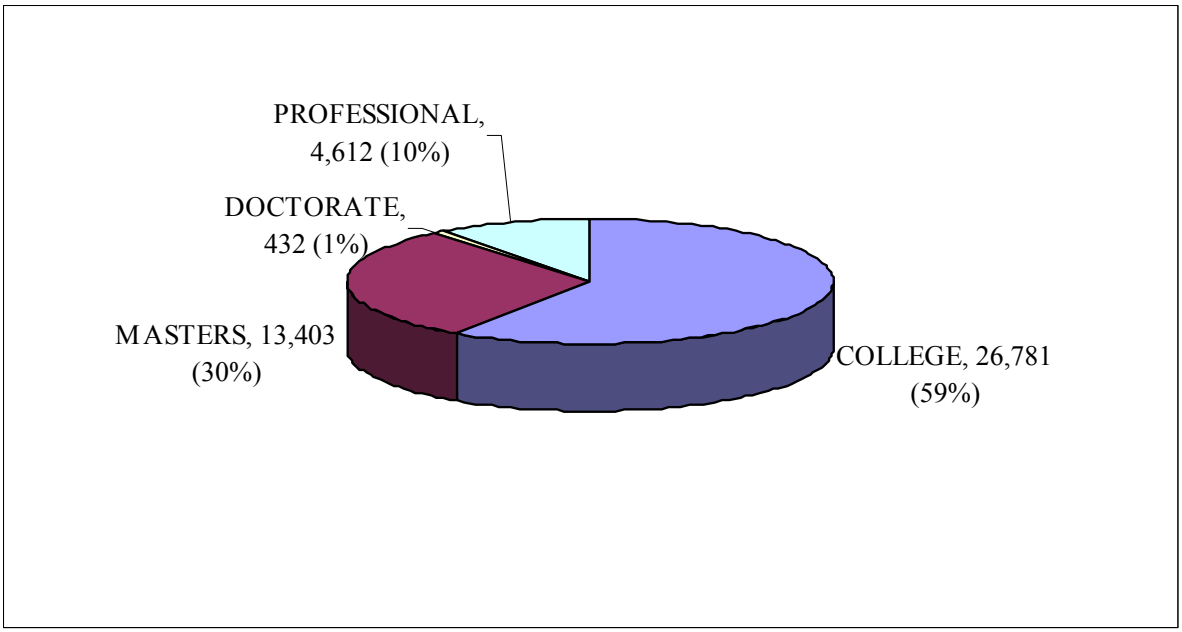


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Rate	0.2	1.8	7.6	18	17	10	7.6	5.8	4.6	3.6	3.1	4	2.5	1.6	1.3	1.1	1	0.6	0.9	4.8	1.6	0.8	0.4	0

Source: Author tabulations based on DMDC data

Figure 4. Separation Rate of Army Officers by Service Years

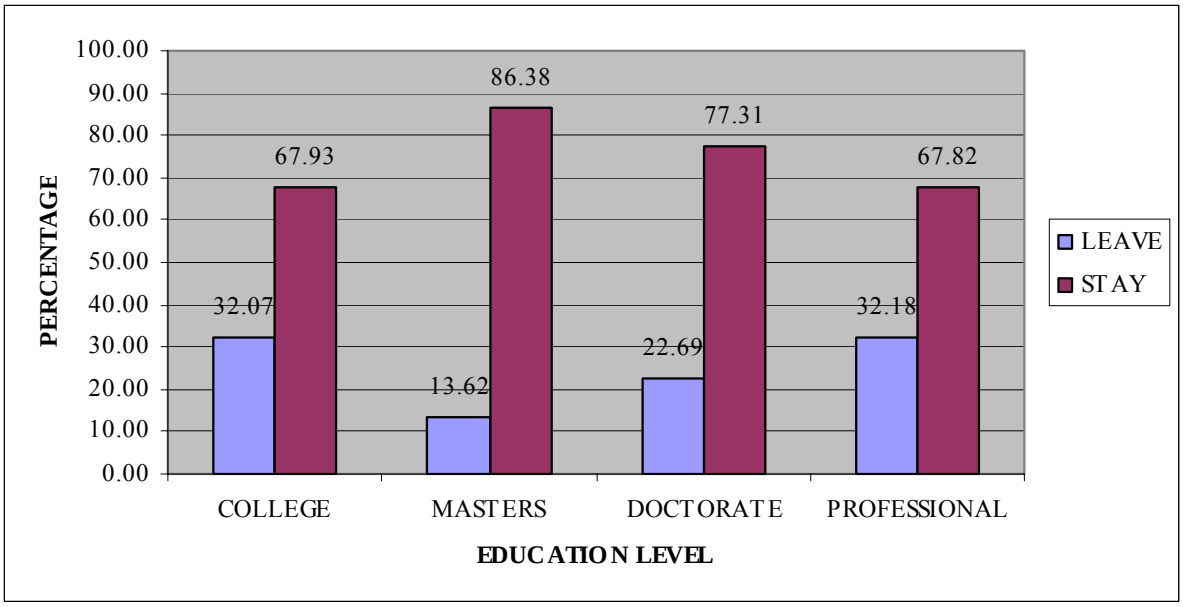
Figure 5 displays the education level of officers, which is the main focus of this study. There are four education levels investigated in this study: college (baccalaureate) degree (COLLEGEDGREE), master's degree (GRADUATEDEGREE), doctorate degree (DOCTORATEDEGREE) and professional degree (PROFESSIONALDEGREE). Education level may change over time, and it is tracked yearly in the data set. Education level used for the analysis is measured at the time of separation if an officer left the Army by 2004. If an officer was still on active duty in September 2004, then the education level observed on that date is used. The majority of the officers (26,781 or 59 percent) are college graduates. The smallest group is the doctorate degree holders, accounting for only 1 percent of all officers. The second largest group is the officers with a master's degree, of which there are 13,403, or 30 percent of all officers. Finally, there are 4,612 officers who have professional degrees. They make up 10 percent of all officers in the study.



Source: Author tabulations based on DMDC data

Figure 5. Education Level of Army Officers in Numbers and Percentages

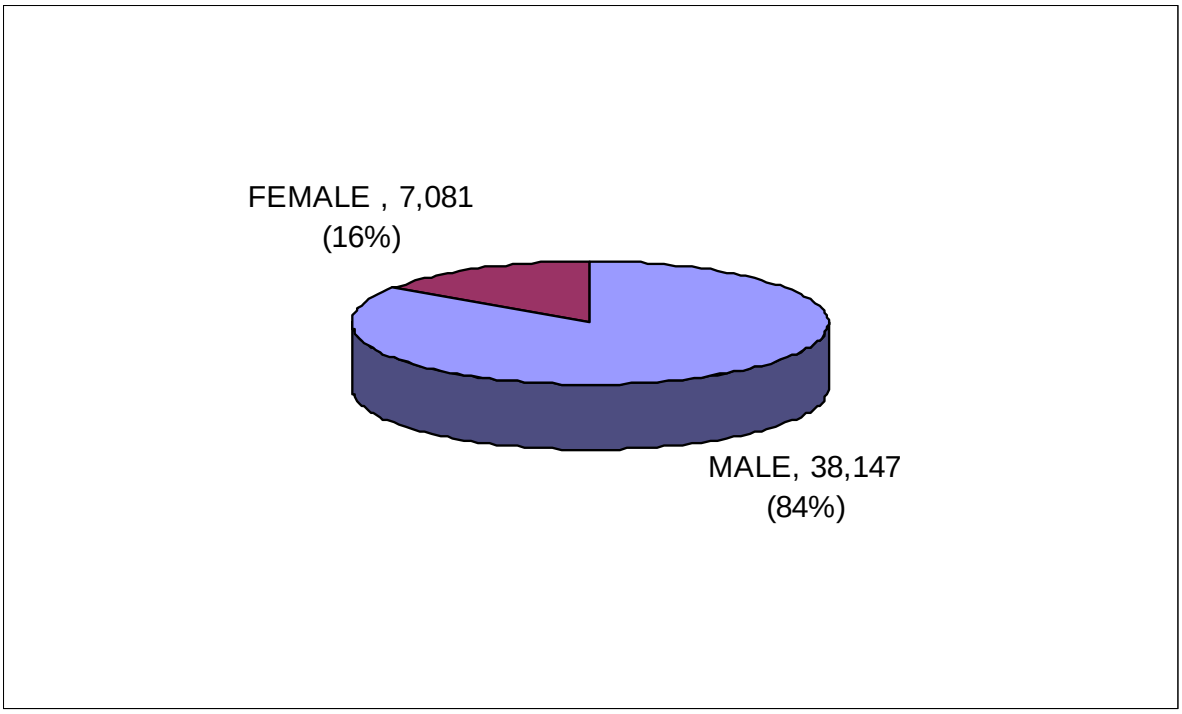
Figure 6 shows separation and continuation rates as of September 30, 2004 by education level for officers who entered commissioned service between 1981 and 2004. Master's degree holders have the lowest separation rates (13.62 percent), whereas college graduates have the highest rate (32.07 percent). Thus, master's degree holders have the greatest survival rate (86.38 percent). College graduates and professional degree holders have approximately the same separation rates, 32.07 percent and 32.18 percent, respectively.



Source: Author tabulations based on DMDC data

Figure 6. Separation and Continuation Percentages as of September 30, 2004 by Education Level for All Army Officers Entering 1981-2004

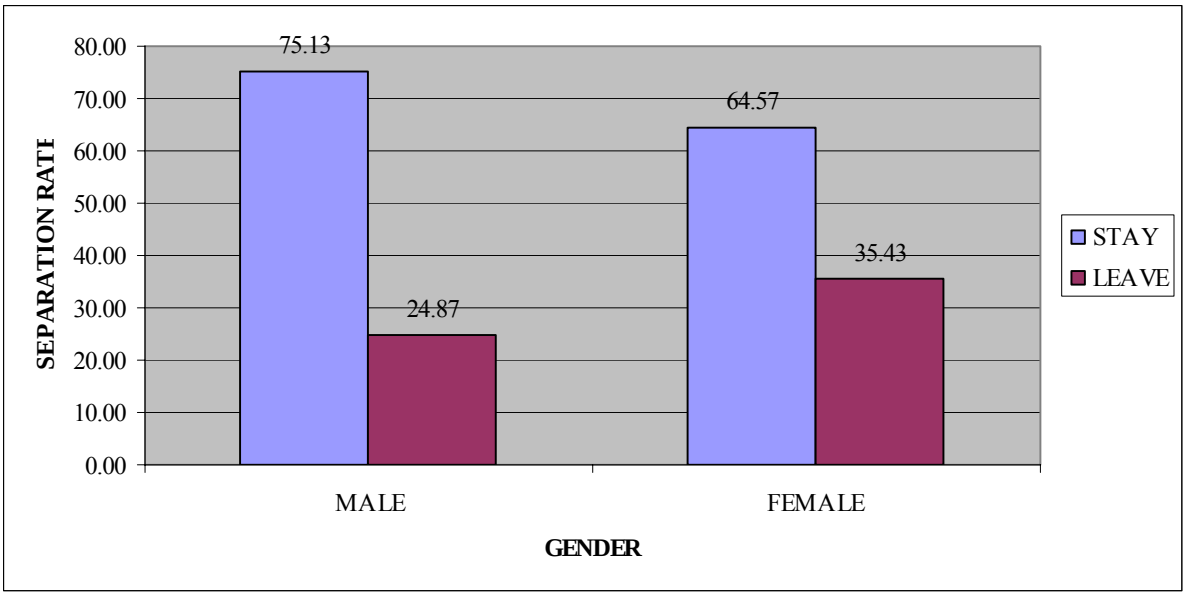
Figure 7 shows both the number and percentage of officers according to their gender. Of 45,228 officers, 38,147 are males (about 84 percent) and 7,081 are females (about 16 percent).



Source: Author tabulations based on DMDC data

Figure 7. Gender of Officers in Numbers (and Percent)

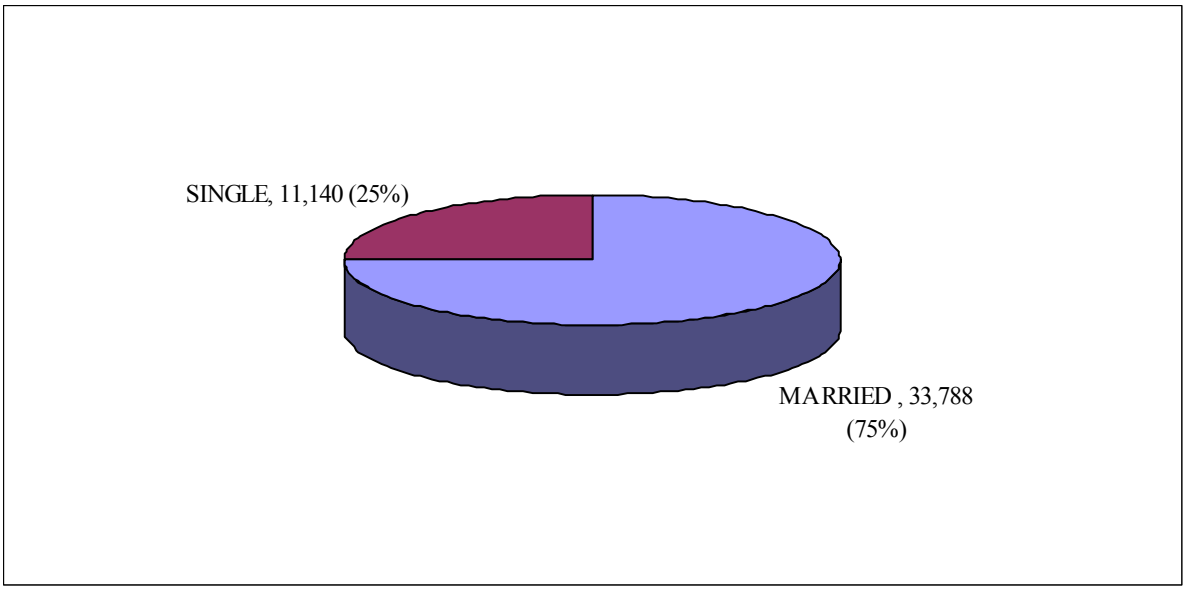
Figure 8 displays separation rates by gender. While 75.13 percent of males who entered the Army as officers between 1981 and 2004 were still in service in 2004, this rate was 64.57 percent for females. In other words, 24.87 percent of males and 35.43 percent of females had left the Army by fiscal year 2004.



Source: Author tabulations based on DMDC data

Figure 8. Separation and Continuation Rates as of September 30, 2004 by Gender for All Army Officers Entering 1981-2004

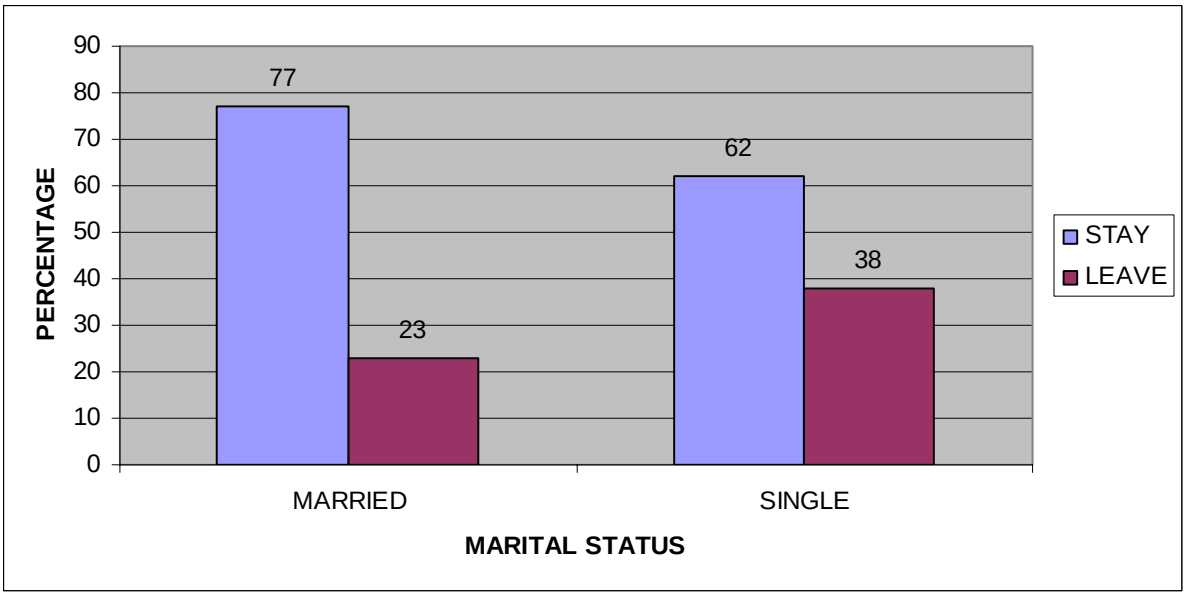
Figure 9 shows the marital status of officers both in numbers and percentages. Marital status is a variable that may change over time; thus, it is tracked yearly. For the retention model, this variable shows marital status at separation date if an officer left the Army by September 30, 2004. If an officer was still in service on September 30, 2004, then it shows marital status on that date. There are 33,788 married officers and 11,140 single officers in the data set. Married officers make up about 75 percent of all officers.



Source: Author tabulations based on DMDC data

Figure 9. Marital Status of Army Officers in Numbers (and Percent)

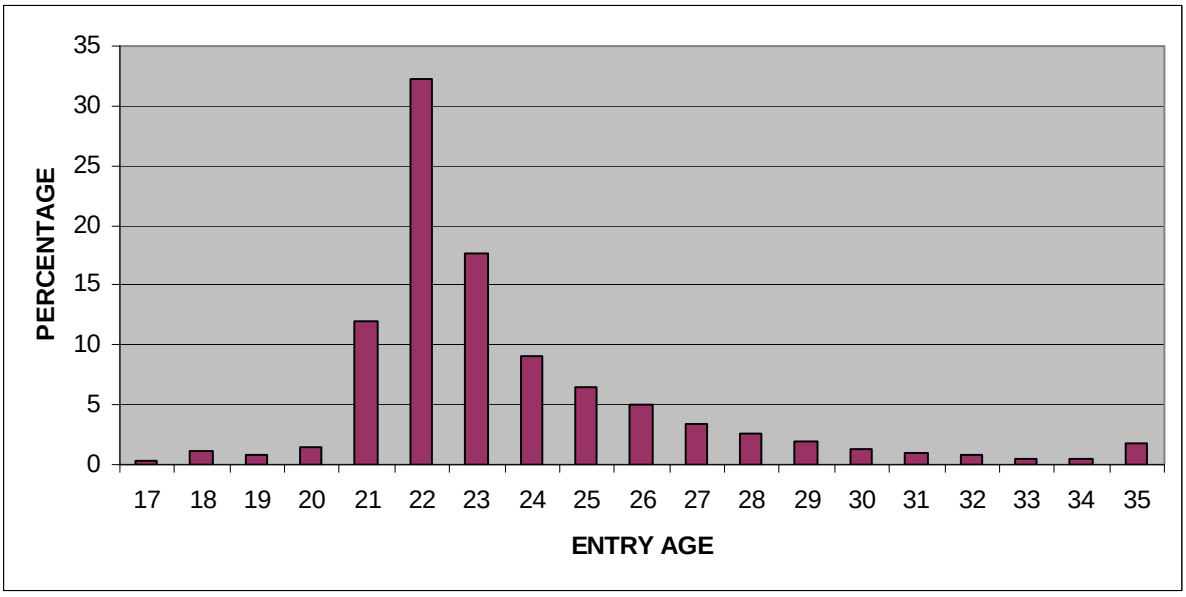
Figure10 displays separation rates by marital status. The separation rate of single officers is greater than that of married officers (38 percent vs. 23 percent). By 2004, 77 percent of married officers were still on active duty. For single officers this rate was 62 percent.



Source: Author tabulations based on DMDC data

Figure 10. Separation and Continuation Percentages as of September 30, 2004 by Marital Status for All Army Officers Entering 1981-2004

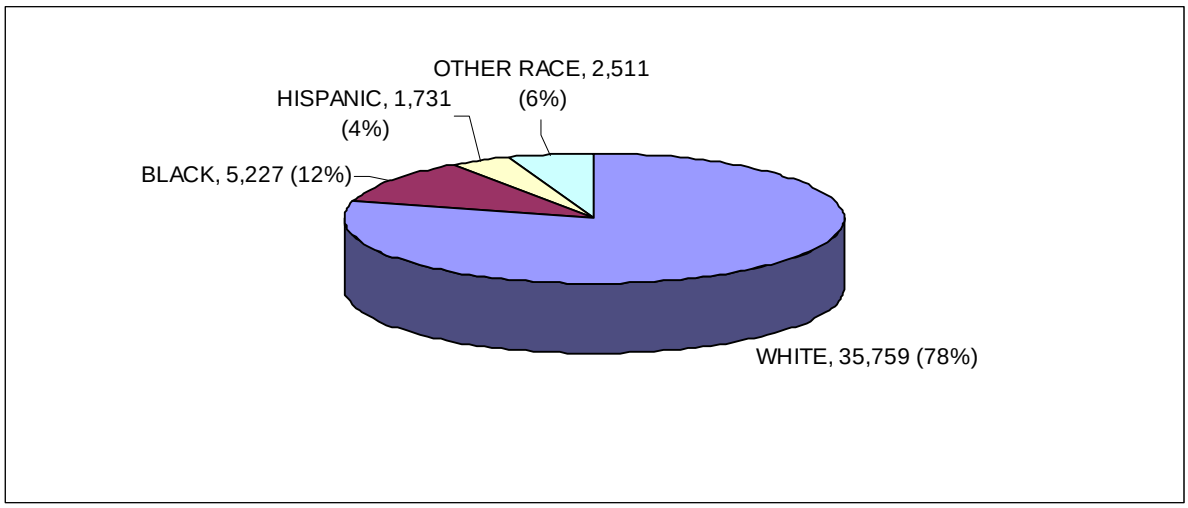
Age at entry for the Army officers in the data set ranges from 17 to 35, as seen in Figure 11. The modal age at the entry is 22 (32.25 percent). The majority of the officers (61.79 percent) enter the military at ages 21, 22, or 23.



Source: Author tabulations based on DMDC data

Figure 11. Age of Army Officers at Entry

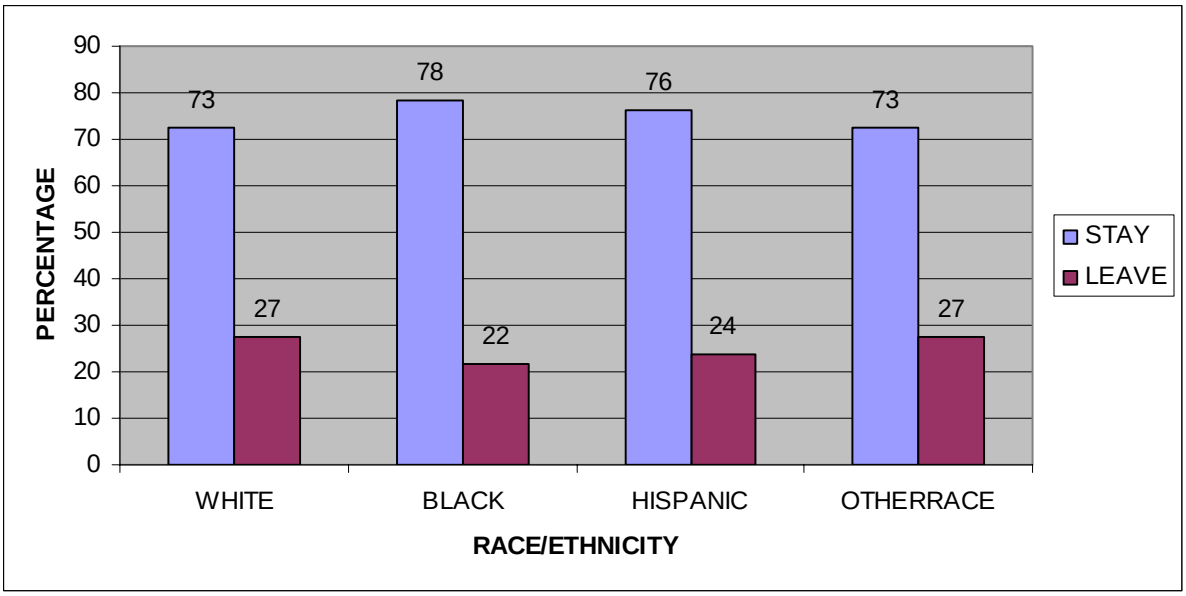
Figure 12 shows the race/ethnicity distribution of the officers. The majority of officers are whites, comprising 78 percent of all officers. The second largest group is blacks, comprising 12 percent of officers. The smallest group is Hispanics, who number 1,731 (4 percent). There are 2,511 officers whose race/ethnicity is other than these three.



Source: Author tabulations based on DMDC data

Figure 12. Race/Ethnicity of Army Officers in Numbers (and Percent)

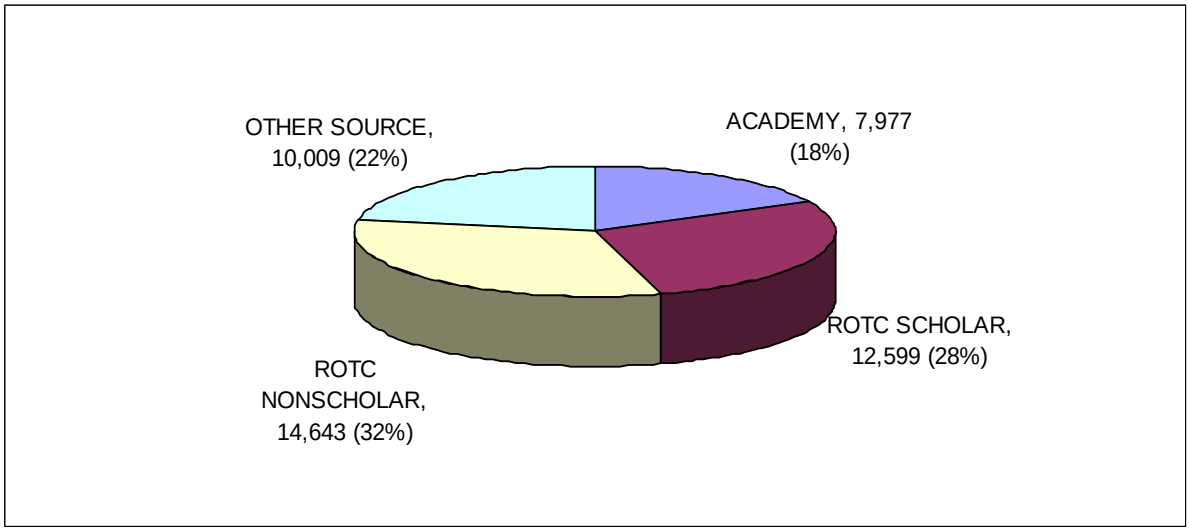
Figure 13 provides information about variation in separation rates among different race/ethnicity groups. Although there seems to be little difference in separation percentages among different race/ethnicity groups, the separation rate of whites and other races is the largest at 27 percent. The group with the second largest separation rate is Hispanics, with a separation rate of 24 percent. Black officers have the highest survival rates among all race/ethnicity groups. Their separation rate is 22 percent and survival rate is 78 percent.



Source: Author tabulations based on DMDC data

Figure 13. Separation and Continuation Rates as of September 30, 2004 by Race/Ethnicity for All Army Officers Entering 1981-2004

Figure 14 displays the commissioning sources of officers. The largest commissioning source is Reserve Officers' Training Corps (ROTC). The number of ROTC non-scholarship officers is 14,643 and they comprise 32 percent of all officers. ROTC scholarship officers follow the non-scholarship officers with 12,599 officers, about 28 percent. United States Military Academy graduates are the smallest group, accounting for 18 percent. The number of officers who were commissioned from any source other than these three major sources is 10,009 (22 percent).

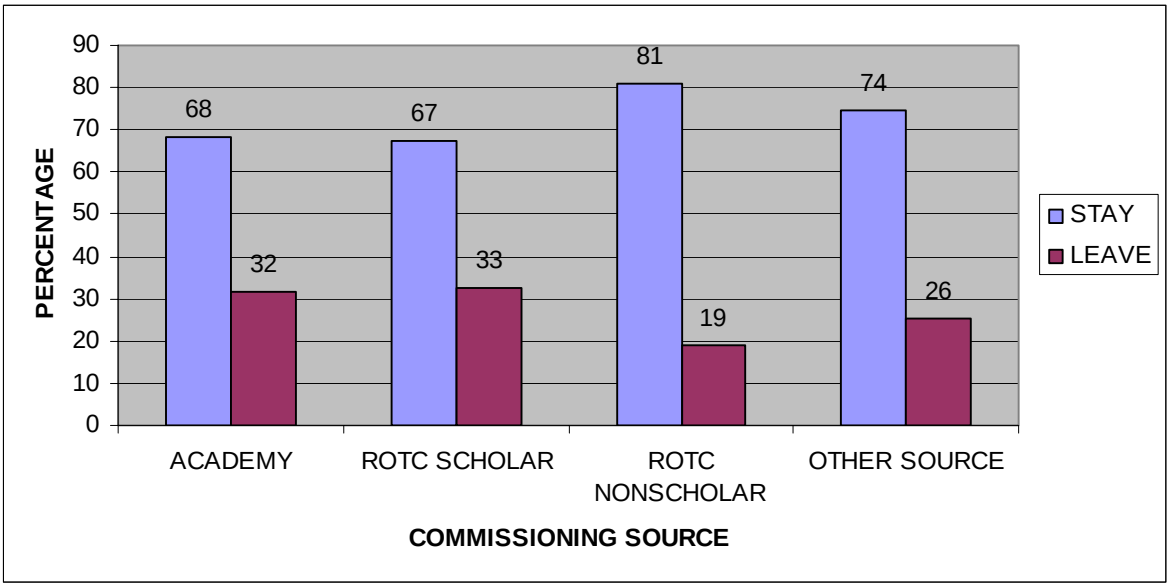


Source: Author tabulations based on DMDC data

Figure 14. Commissioning Sources of Army Officers in Numbers (and Percent)

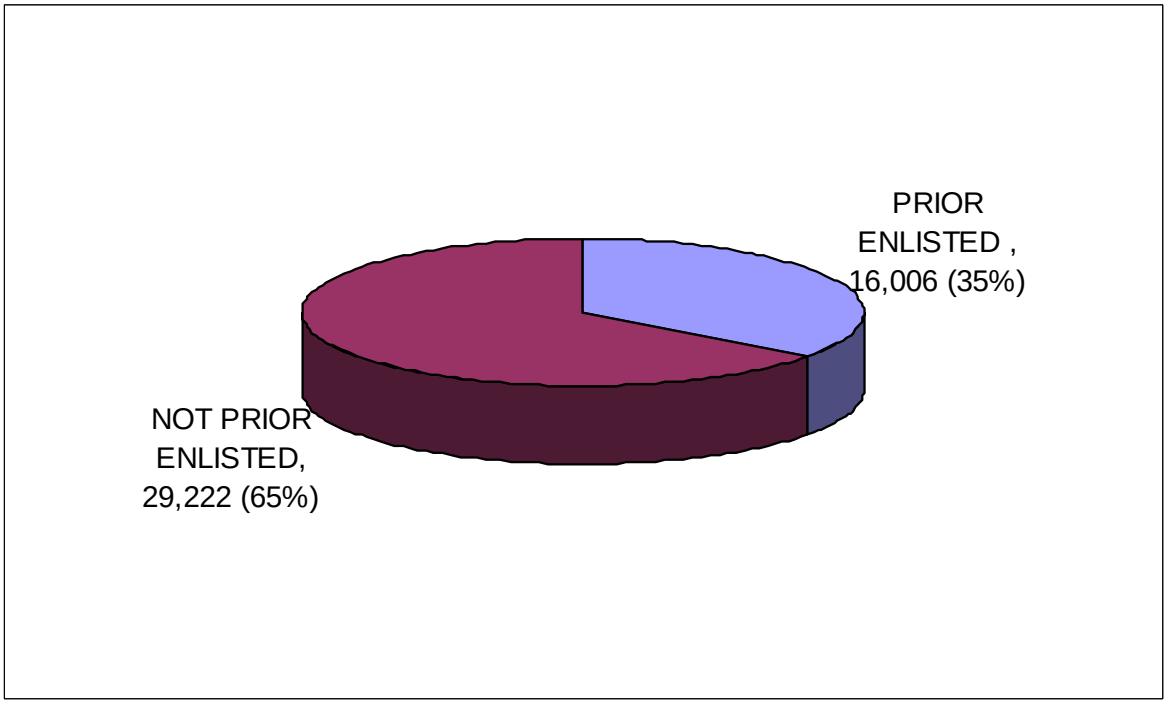
Figure 15 provides information on separation rates by commissioning source. Officers whose commissioning source is an ROTC scholarship have the largest separation rate (33 percent). Academy graduates follow this group with 32 percent. The group with the third highest separation rate is those commissioned from another source, with a rate of 26 percent. ROTC non-scholarships have the smallest separation rate (19 percent) and thus, have the highest survival rate (81 percent).

Figure 16 provides information about the prior enlistment status of officers. About 35 percent (16,006) of officers served as enlisted personnel before being commissioned as officers.



Source: Author tabulations based on DMDC data

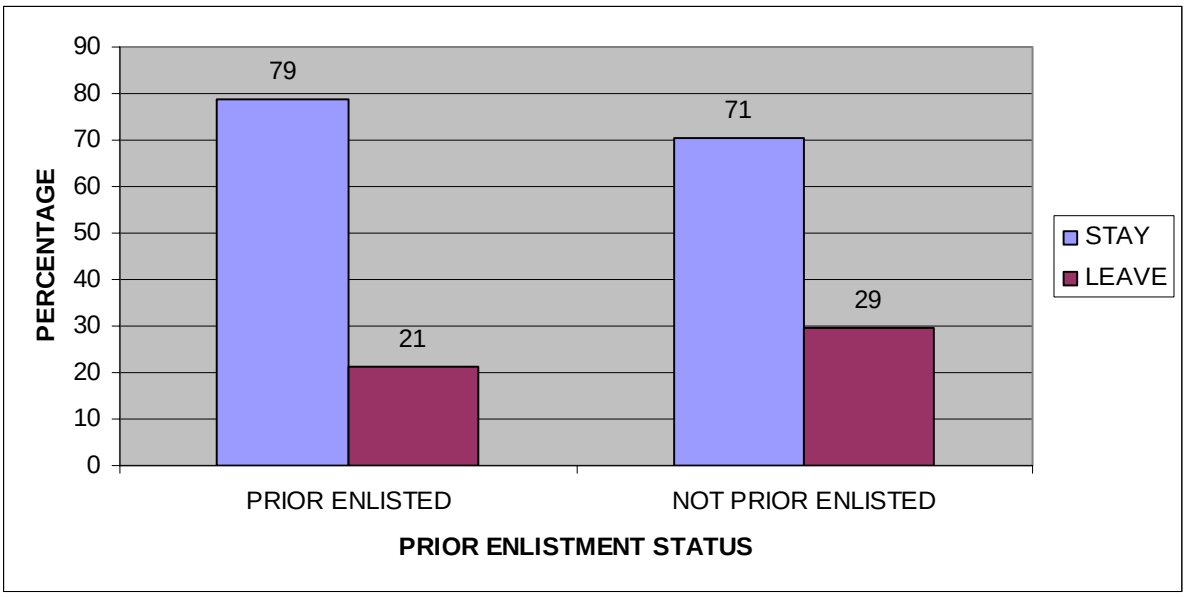
Figure 15. Separation and Continuation Rates as of September 30, 2004 by Commissioning Source for All Army Officers Entering 1981-2004



Source: Author tabulations based on DMDC data

Figure 16. Number (and Percentage) of Army Officers by Prior Enlistment Status

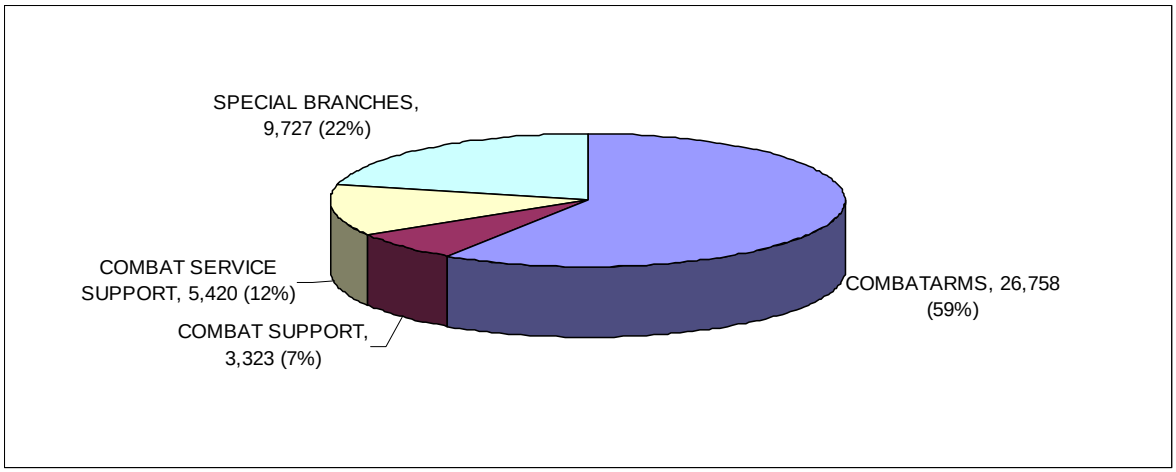
Figure 17 shows separation rates by prior enlistment status. As seen in the figure, the separation rate of officers who were not prior enlisted is greater than that of officers who served as enlisted before being commissioned as an officer.



Source: Author tabulations based on DMDC data

Figure 17. Separation and Continuation Rates as of September 30, 2004 by Prior Enlistment Status for All Army Officers Entering 1981-2004

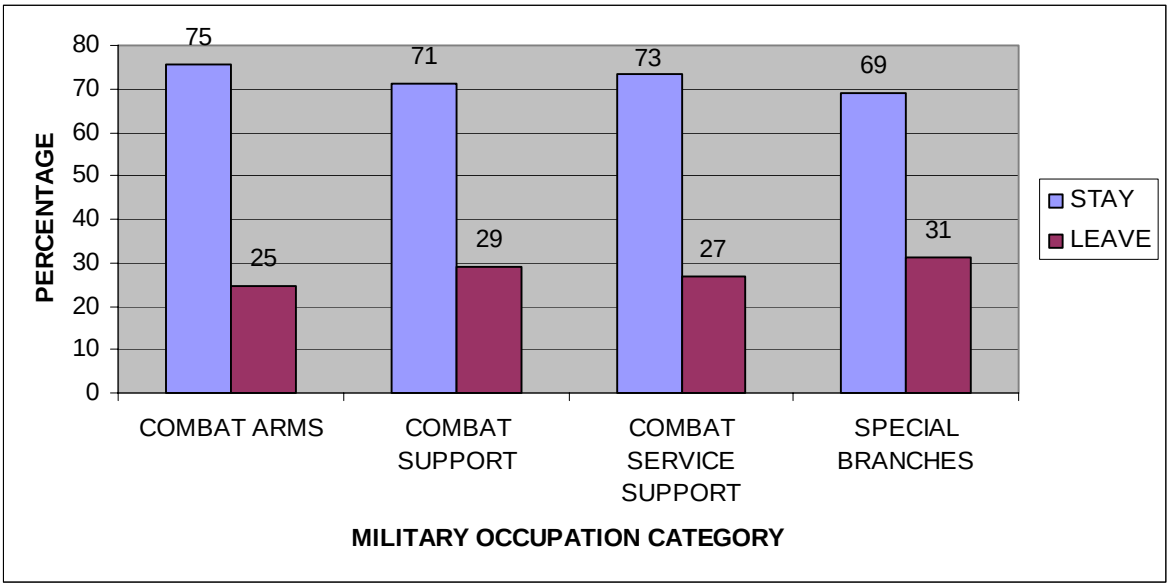
Figure 18 shows the number of officers by their occupational specialties. The majority of the officers (59 percent) serve in the Combat Arms Specialty, and they number 26,758. Officers who serve in Special Branches and in the Combat Service Support Category number 9,727 (22 percent) and 5,420 (12 percent), respectively. The smallest group among these four categories is the Combat Support Group, whose number is 3,323 and who make up only 7 percent of all officers.



Source: Author tabulations based on DMDC data

Figure 18. Number (and Percentage) of Army Officers by Military Occupational Specialty (MOS)

Figure 19 shows separation and continuation rates by occupational categories. Special Branches Category has the highest separation rate (31 percent). This category is followed by Combat Support and Combat Service Support, with separation rates of 29 percent and 27 percent respectively. The smallest separation rate is 25 percent for the Combat Arms category. Officers who serve in Combat Arms have the highest survival rates.



Source: Author tabulations based on DMDC data

Figure 19. Separation and Continuation Rates as of September 30, 2004 by Military Occupational Specialty for All Army Officers Entering 1981-2004

2. Promotion

The table in Appendix B summarizes all characteristic distribution and promotion rates by the independent variables. This table presents all independent variables, their distribution among officers, and promotion rates according to the explanatory variables in both numbers and percentages.

The duration variable for the promotion model is TIMEYRS, which shows how long it takes officers to be promoted to MAJOR (O-4). It shows number of years until separation or until September 30, 2004 for those who were not promoted to major.

According to Department of Defense Instruction 1320.14, *Commissioned Officer Promotion Program Procedures*[97], an officer should serve nine to eleven years in order to be promoted to O-4. Officers promoted below the zone have eight years of service. Furthermore, according to Army Regulation 600-8-29, *Officer Promotions*[98] and Army

[97] *Department of Defense Instruction 1320.14, Commissioned Officer Promotion Program Procedures,* (Washington DC, Headquarters, Department of Defense, September 24, 1996).

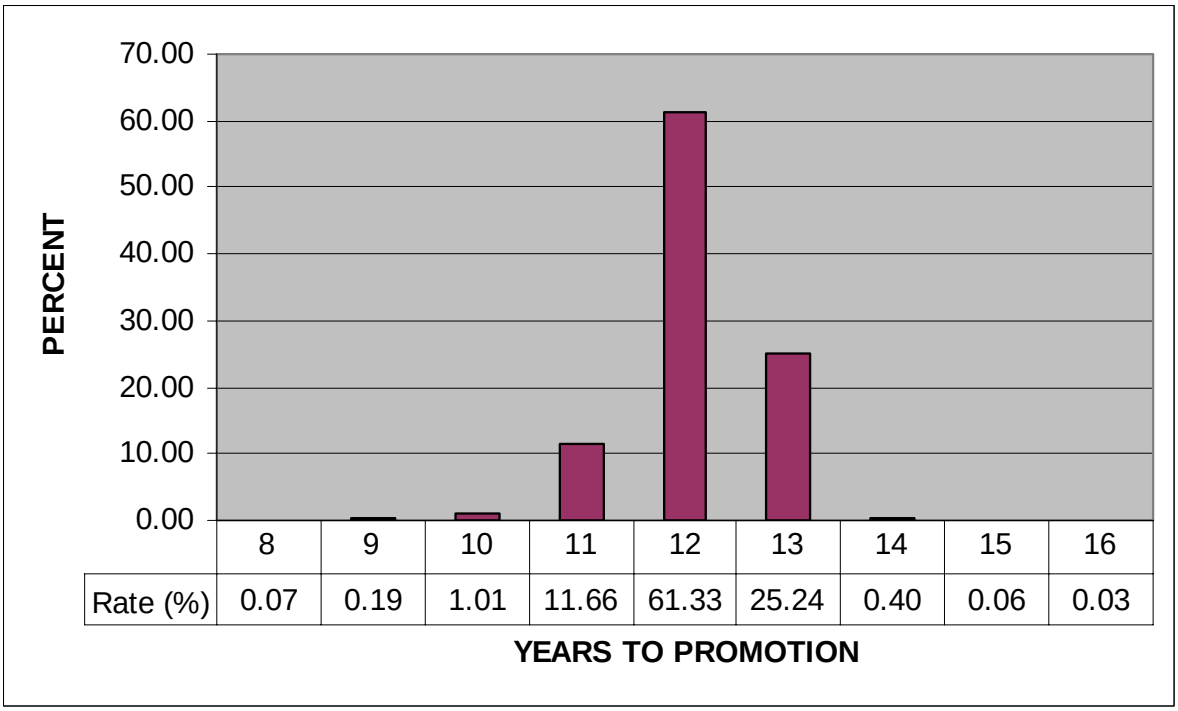
[98] *Army Regulation 600-8-29, Officer Promotions* (Department of the Army Headquarters, Washington DC, 25 February 2005).

Regulation 135-155*, Promotion of Commissioned Officers and Warrant Officers Other Than General Officers,*[99] an officer must serve at least two years as a second lieutenant in order to be promoted to lieutenant, at least two years in order to be promoted to captain, and at least three years in order to be promoted to major. Thus, an officer must serve at least seven years in the lower ranks in order to be promoted to major. For these reasons, only officers who served at least eight years are used for the analysis. Those who left before eight years of service or those who did not serve at least eight years by September 30, 2004 are deleted. As a result, officers commissioned after 1996 are not used for the analysis.

The censoring variable for promotion analysis is PROMO4. It takes on a value of one if an officer is promoted to O-4 by September 30, 2004. It takes on a value of zero if an officer was not promoted to major by that date or if an officer left the service after serving at least eight years but was not promoted to O-4. Thus, officers who were not promoted to major for any reason are censored.

Figure 20 shows the number of years it takes to be promoted to major. As seen in the figure, the majority of officers (61.33 percent) are promoted after serving 12 years. The second largest group is the officers promoted to major after serving 13 years (25.24 percent). The third group is represented by those promoted after 11 years (11.66 percent). There are a few officers promoted to O-4 after serving 8 years (0.07 percent), 9 years (0.19 percent), 10 years (1.01 percent), 14 years (0.40 percent), 15 years (0.06 percent) or 16 years (0.03 percent).

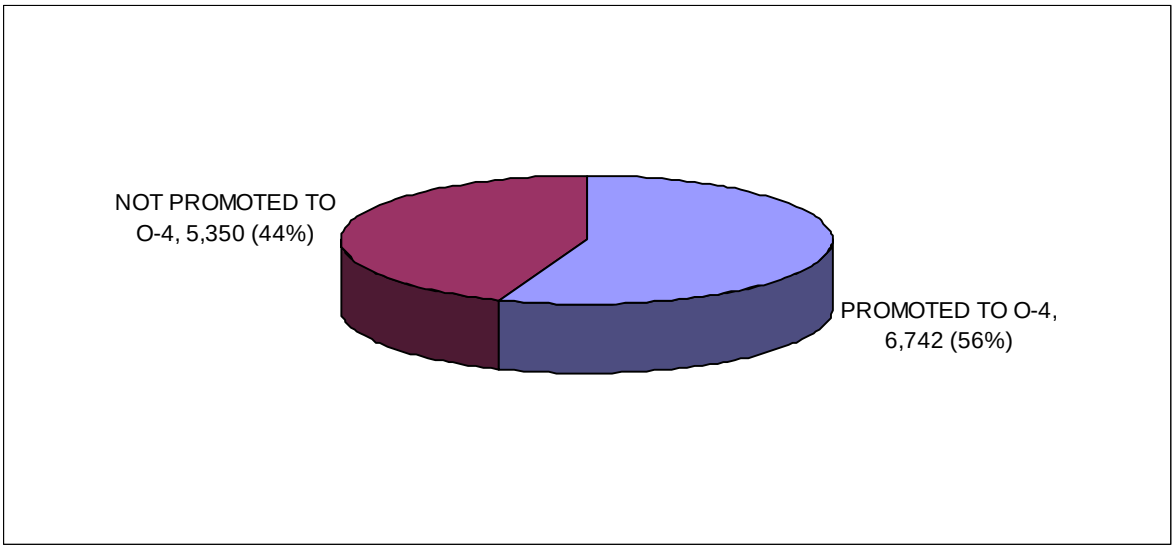
99 *Army Regulation 135-155, Promotion of Commissioned Officers and Warrant Officers Other Than General Officers* (Department of the Army Headquarters, Washington, DC, 13 July 2004).



Source: Author tabulations based on DMDC data

Figure 20. Promotion Rates to MAJOR by Years of Service for all Army Officers Entering 1981- 1985

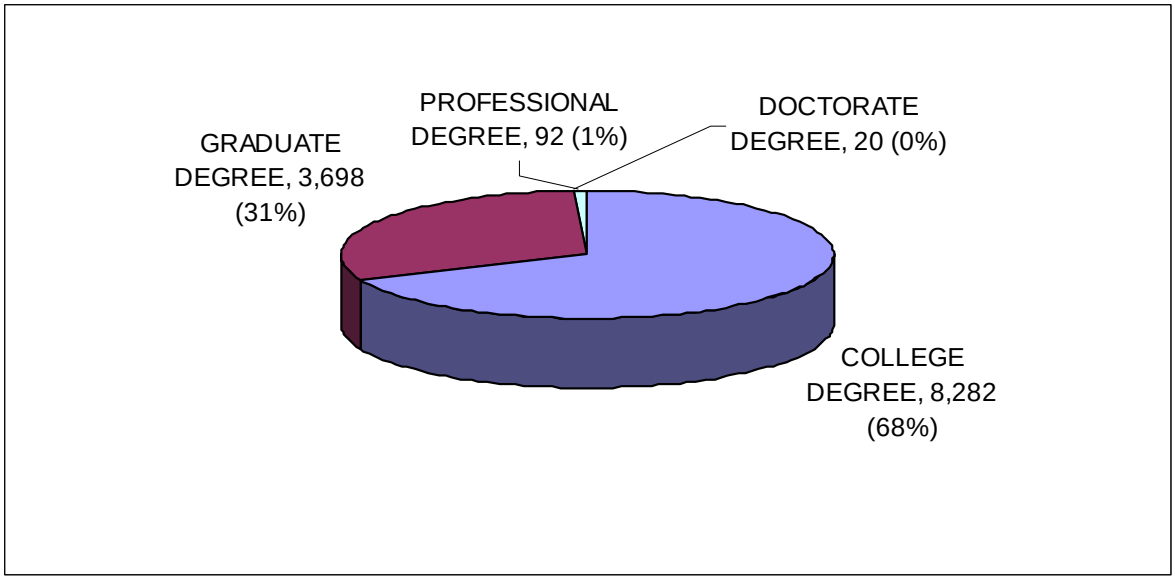
Figure 21 displays the number and percentage of officers promoted and not promoted to major. The promotion analysis contained 12,092 officers who were commissioned between 1981 and 1995 and who survived to eight years of service.. Of those 12,092 officers, 6,742 (56 percent) officers were promoted to O-4 and 5,350 (44 percent) officers were not promoted to O-4 by September 30, 2004. Officers who were not promoted are censored in survival analysis. Some of those censored officers left the Army by September 30, 2004.



Source: Author tabulations based on DMDC data

Figure 21. Number and Percentage of Officers Entering the Army between 1981 and 1995 Who Were Promoted to O-4 by September 30, 2006

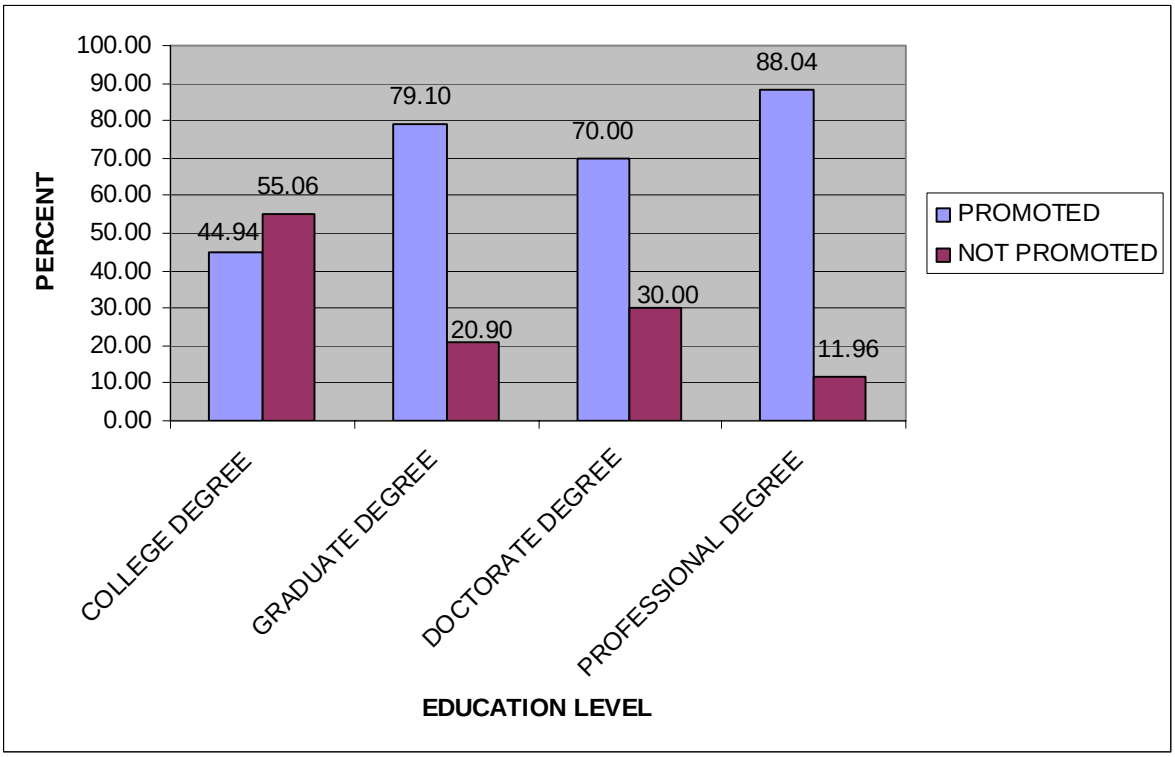
Figure 22 displays the education level of officers used for promotion analysis. Education level is measured at the time of promotion if an officer was promoted to major by 2004. If an officer was not promoted by September 30, 2004 or left the service before that time without being promoted to O-4, then the education level observed on September 30, 2004 or on the separation date is used. The majority of the officers (8,282 or 68 percent) are college graduates. Doctorate degree holders comprise the smallest group, accounting for only less than 1 percent of all officers (20 officers). Officers with a master's degree account for the second largest group, totaling 3,698 and comprising 31 percent of all officers. Finally, there are 92 officers who have professional degrees. They make up 1 percent of all officers used in the study.



Source: Author tabulations based on DMDC data

Figure 22. Education Level of Army Officers in Numbers (and Percent)

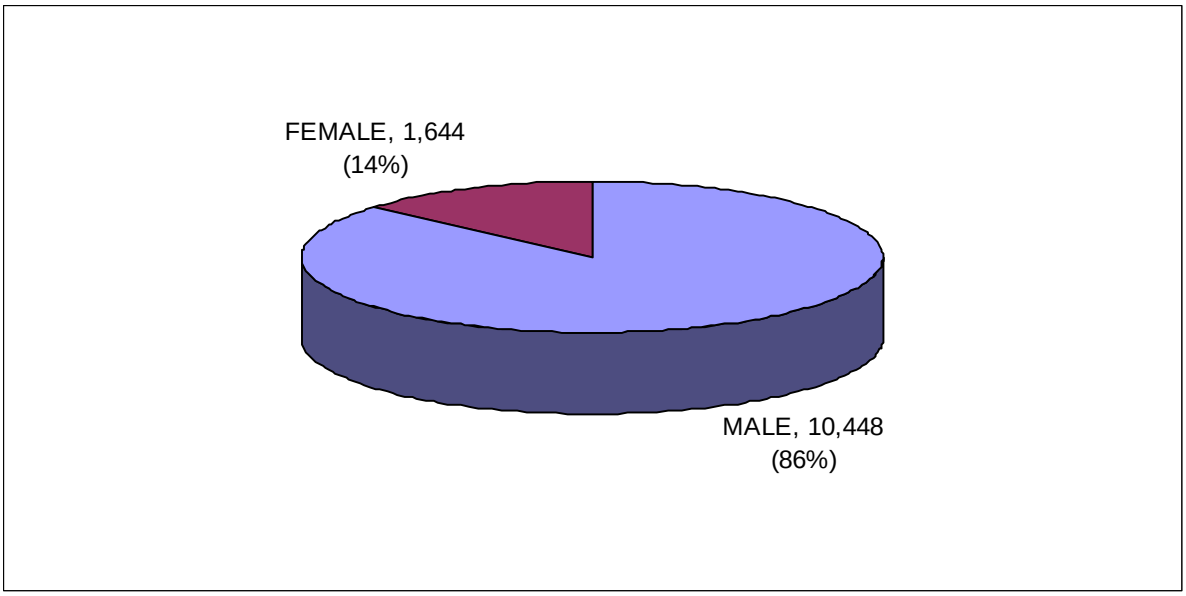
Figure 23 shows promotion rates as of September 30, 2004 by education level for officers who entered commissioned service between 1981 and 1995. Professional degree holders have the highest promotion rates (88.04 percent), whereas college graduates have the lowest rate (44.94 percent). Of officers with master's degrees, 79.10 percent were promoted to O-4. Finally, 70 percent of officers with doctorate degrees were promoted to major. There seems to be a substantial difference in promotion rates between officers with advanced degrees (master's, doctorate and professional degrees) and officers with college degrees.



Source: Author tabulations based on DMDC data

Figure 23. Promotion Rates of Army Officers Entering the Army between 1981 and 1995 by Education Level, as of September 30, 2004

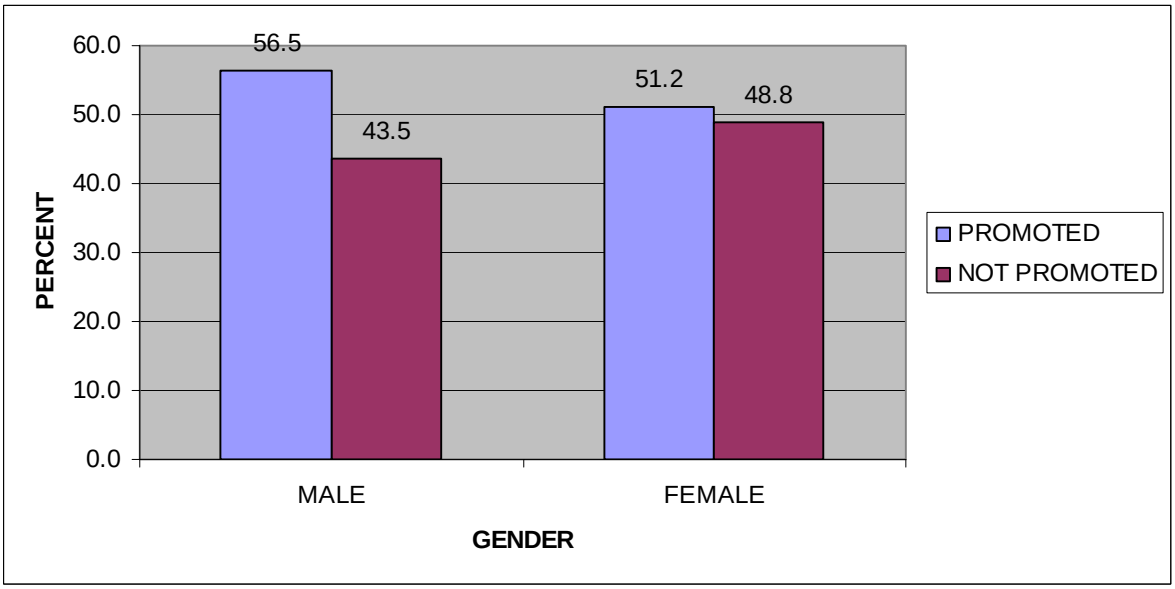
Figure 24 displays the number and percentage of officers according to their gender. Of 12,092 officers in the promotion analysis, 10,448 are male (86 percent) and 1,644 are female (14 percent).



Source: Author tabulations based on DMDC data

Figure 24. Gender of Army Officers in Numbers and Percentages

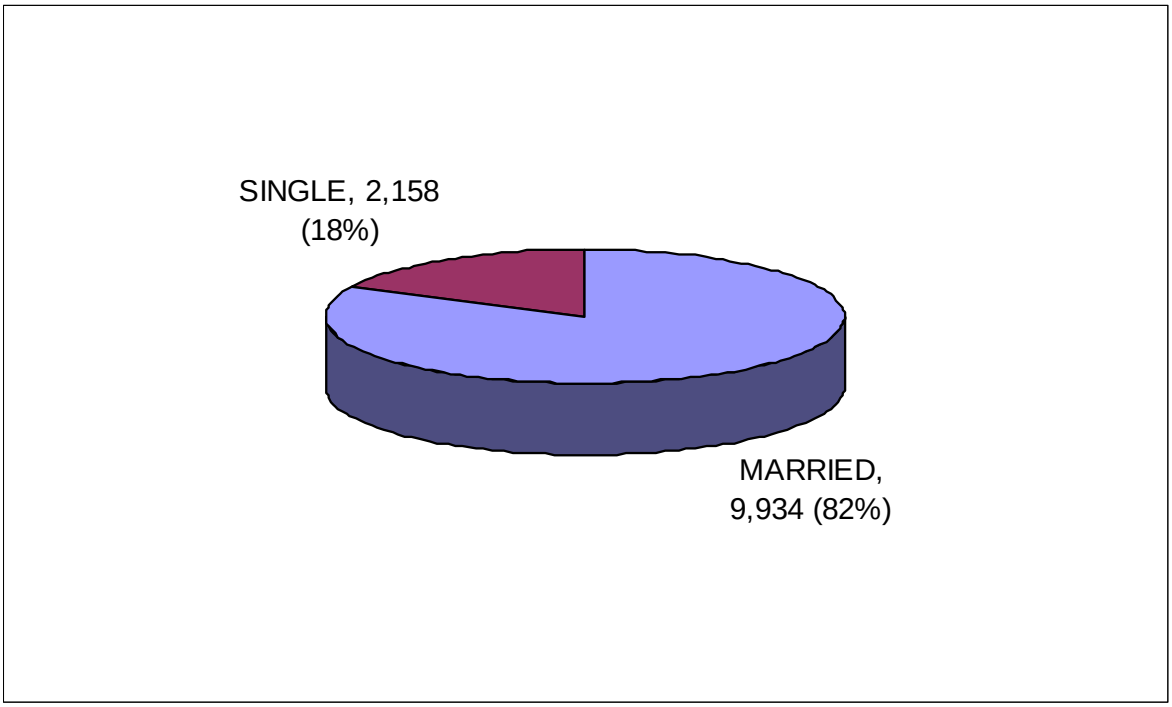
Figure 25 shows the promotion rates of officers by gender as of September 30, 2004. While 56.5 percent of male officers were promoted to O-4, 51.2 percent of female officers were promoted to major.



Source: Author tabulations based on DMDC data

Figure 25. Promotion Rates as of September 30, 2004 by Gender for Army Officers Entering 1981-1995

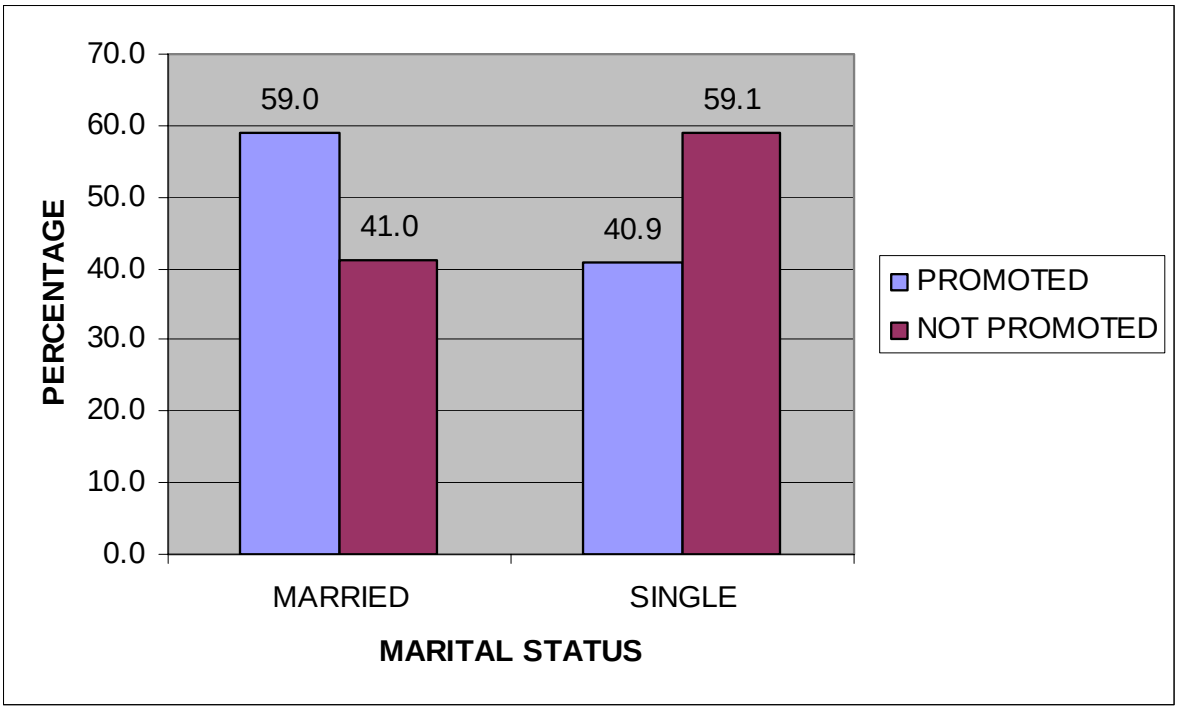
Figure 26 displays marital status of officers both in numbers and in percentages. Marital status is a variable that is tracked yearly. For the promotion model this variable shows marital status at promotion date if an officer was promoted to O-4 by September 30, 2004. If an officer was not promoted to major by that date and was still in service, or separated from the Army by September 30, 2004, then it shows marital status on September 30, 2004 or on the separation date. There are 9,934 married officers and 2,158 single officers in the data set. Married officers make up about 82 percent of all officers.



Source: Author tabulations based on DMDC data

Figure 26. Marital Status of Army Officers in Number and Percentage

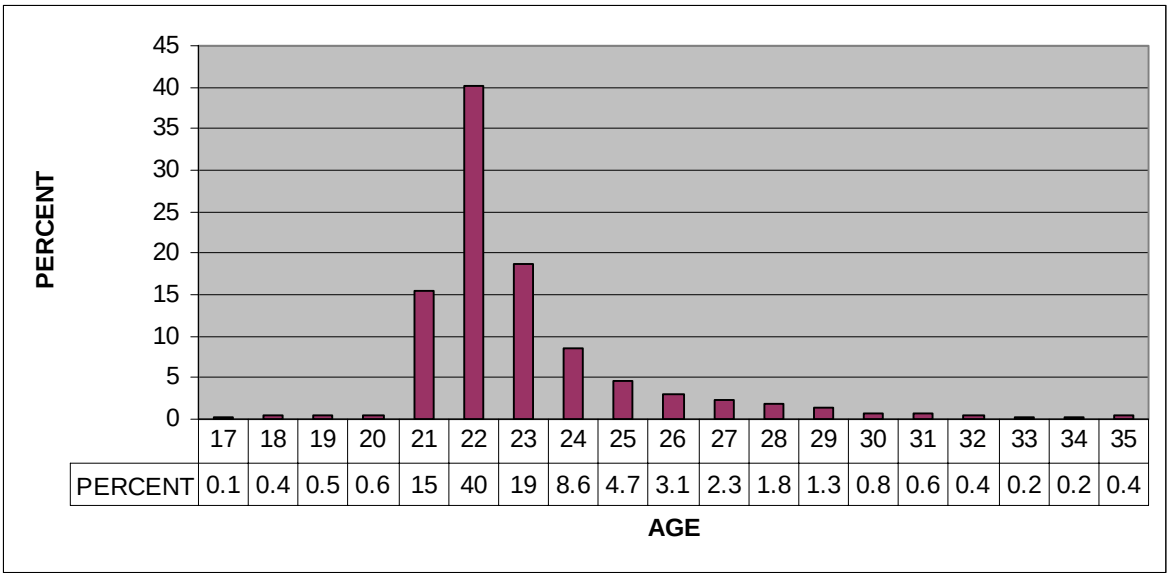
Figure 27 shows promotion rates for officers as of September 30, 2004 by marital status. While 59 percent of married officers were promoted to O-4, only 40.9 percent of single officers were promoted to major. The promotion percentage for married officers is almost 20 percent greater than that of single officers.



Source: Author tabulations based on DMDC data

Figure 27. Promotion Rates as of September 30, 2004 by Marital Status for Army Officers Entering 1981-1995

Age at entry for the Army officers in the data set ranges from 17 to 35, as seen in Figure 28. The modal age at entry is 22 (40 percent). The majority of the officers (74 percent) enter the military at ages 21, 22, or 23.

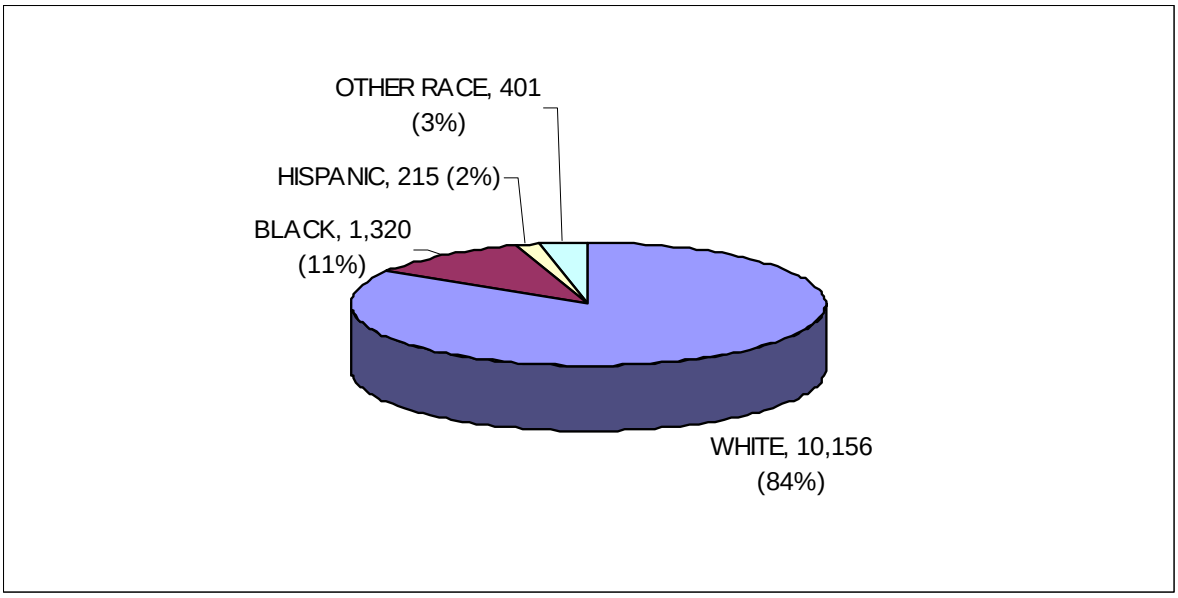


	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
PERCENT	0.1	0.4	0.5	0.6	15	40	19	8.6	4.7	3.1	2.3	1.8	1.3	0.8	0.6	0.4	0.2	0.2	0.4

Source: Author tabulations based on DMDC data

Figure 28. Age of Army Officers at Entry

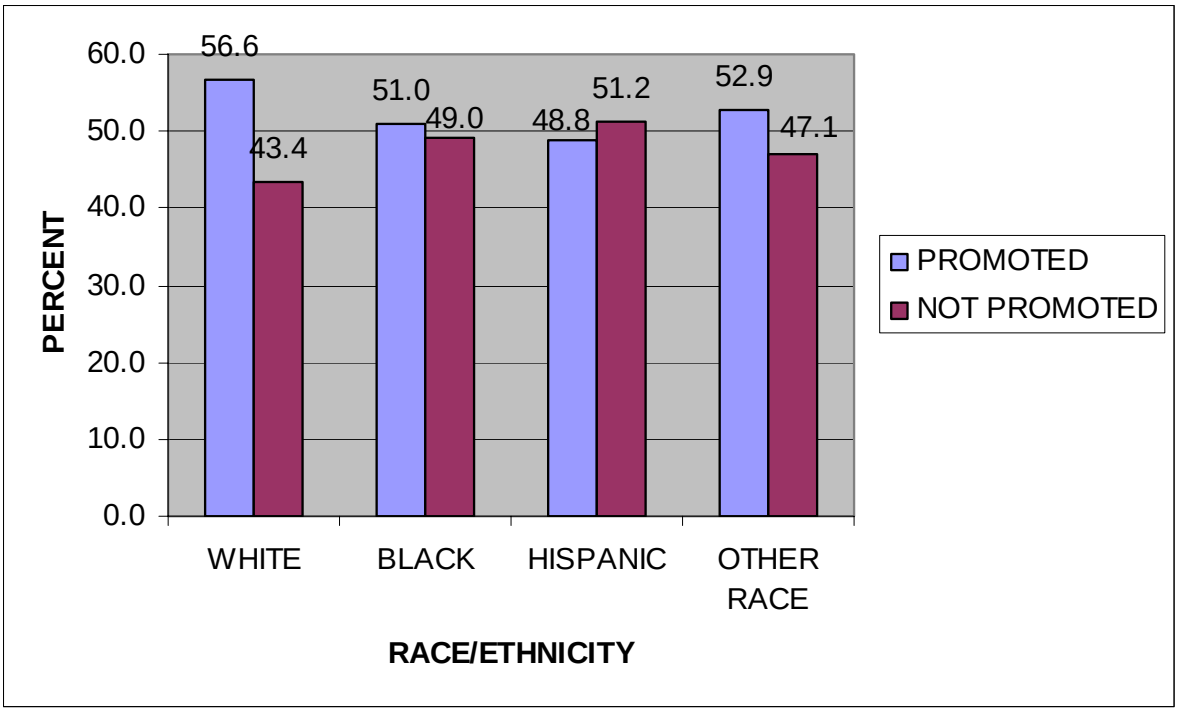
Figure 29 shows the race/ethnicity distribution of the officers. The majority of officers are white, making up 84 percent of all officers. The second largest group is black, comprising 11 percent of officers. The smallest group is Hispanics, who number 215 (2 percent). There are 401 officers whose race/ethnicity is other than these three (3 percent).



Source: Author tabulations based on DMDC data

Figure 29. Race/Ethnicity of Army Officers in Numbers and Percentages

White officers have the greatest promotion rate, as seen in Figure 30. Of white officers, 56.6 percent were promoted to major. Hispanics have the lowest rate, which is 48.8 percent. The group with the second highest promotion rate is officers whose race/ethnicity is other than the main three, with a promotion rate of 52.9 percent. Black officers have the third highest promotion rate at 51 percent. There seems to be little difference in promotion percentages among different race/ethnicity groups.

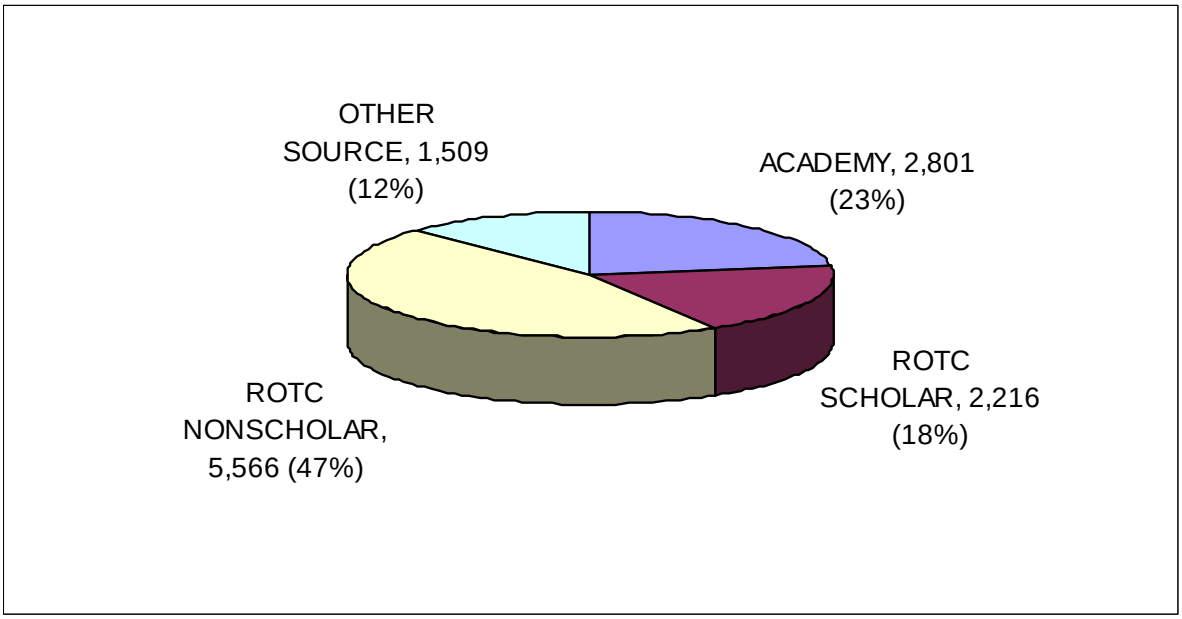


Source: Author tabulations based on DMDC data

Figure 30. Promotion Rates as of September 30, 2004 by Race/Ethnicity for Army Officers Entering 1981-1995

Figure 31 displays the commissioning sources of officers. The largest commissioning source is Reserve Officers' Training Corps (ROTC). The number of ROTC non-scholarship officers is 5,566 and they comprise 47 percent of all officers. U.S. Military Academy graduates follow the non-scholarship officers with 2,801 officers, about 23 percent. ROTC scholarship officers are the third largest group, totaling 2,216 (18 percent). The number of officers who were commissioned from any source other than these three major sources is 1,509 (12 percent), and they are the smallest group among officers commissioned between 1981 and 1995. Other sources include Officer Candidate School (OCS), direct appointments and the "Green-to-Gold Program." This program is an accession program unique to the Army and aimed at enlisted service

members who have served at least two years. These enlisted personnel can request discharge from active duty and enroll in ROTC. After graduating from college, they are commissioned as officers.[100]

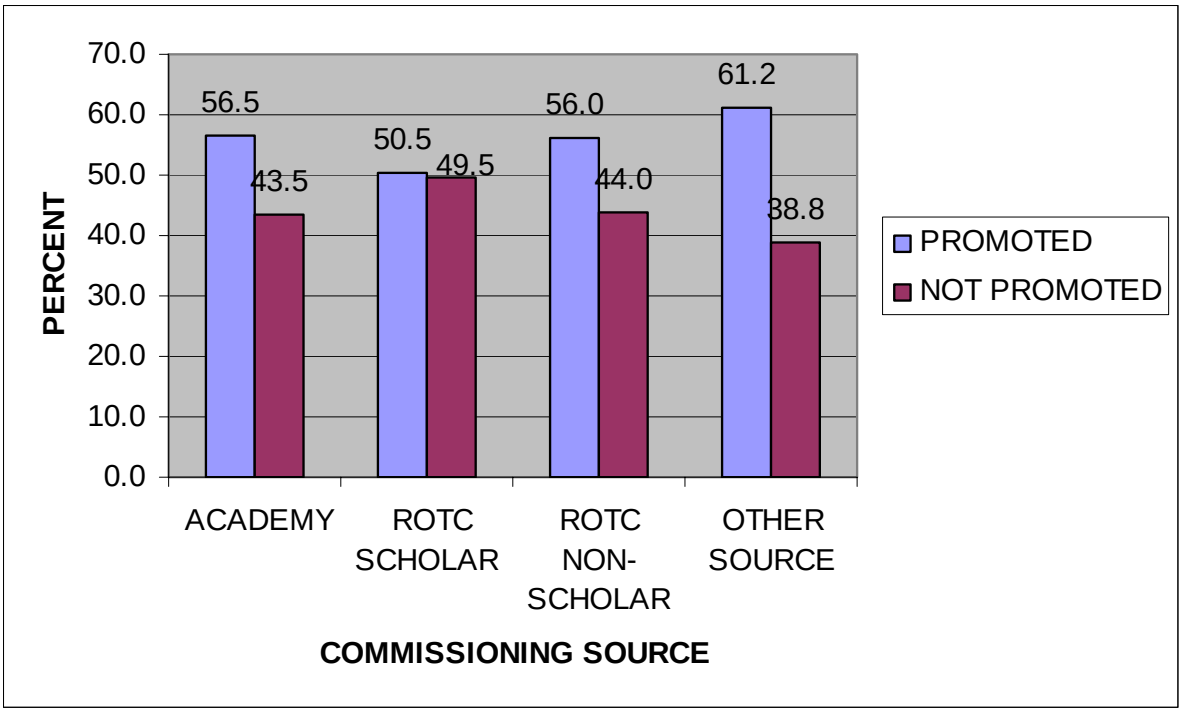


Source: Author tabulations based on DMDC data

Figure 31. Commissioning Source of Army Officers in Numbers and Percentages

Figure 32 provides information on promotion rates by commissioning source. Officers whose commissioning source is other than the three major sources have the highest promotion rate (61.2 percent). Academy graduates follow them with 56.5 percent. The group with the third highest promotion rate is ROTC non-scholar officers, with a rate of 56 percent. ROTC scholarship officers have the lowest promotion rate (50.5 percent).

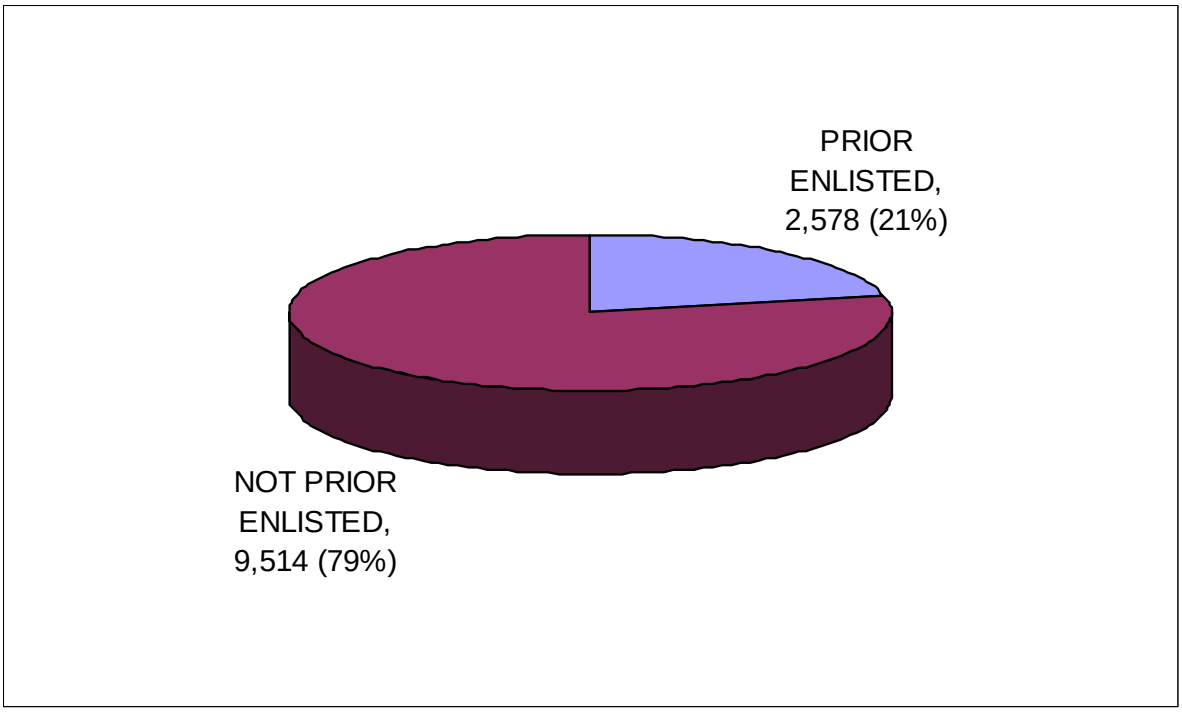
[100] Michael R.Thirtle, *Educational Benefits and Officer-Commissioning Opportunities Available to US Military Service Members,* (Santa Monica, CA: The RAND Corporation, 2001), 29-31.



Source: Author tabulations based on DMDC data

Figure 32. Promotion Rates as of September 30, 2004 by Commissioning Source for Army Officers Entering 1981-1995

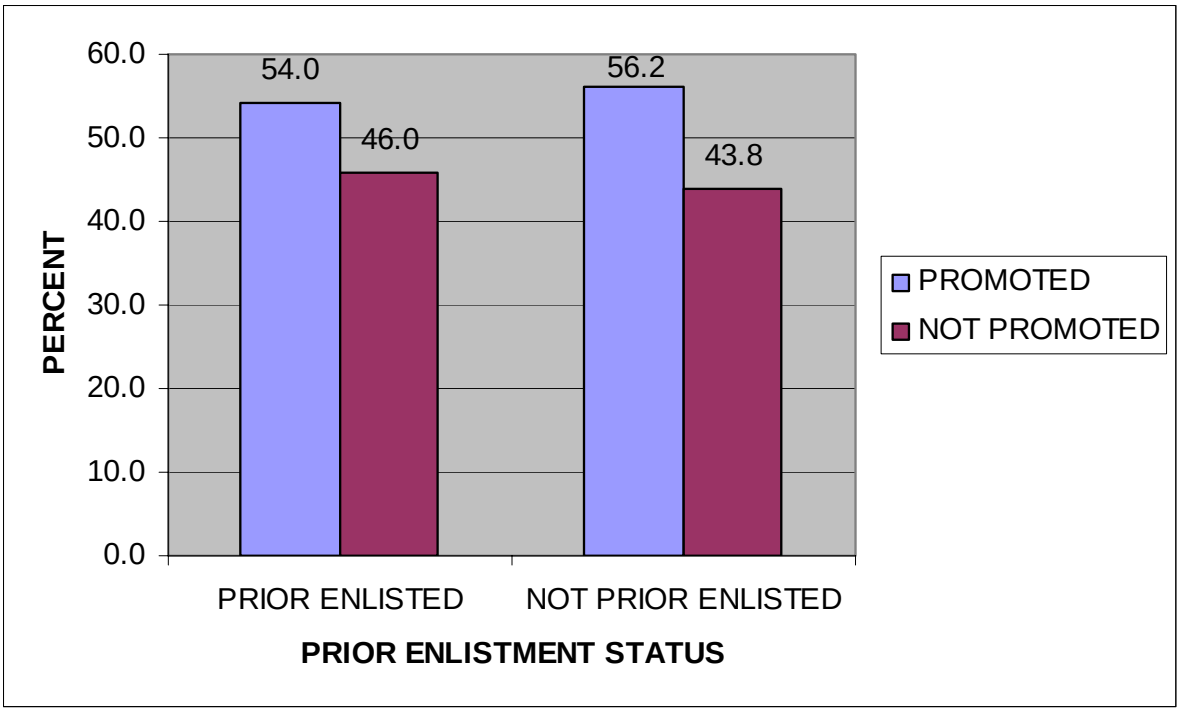
Figure 33 shows the rates of prior enlisted officers. Of 12,092 officers, 2,578 (21 percent) were prior enlisted and 9,514 (79 percent) had not served as enlisted before being commissioned as an officer.



Source: Author tabulations based on DMDC data

Figure 33. Number and Percentage of Army Officers by Prior Enlistment Status

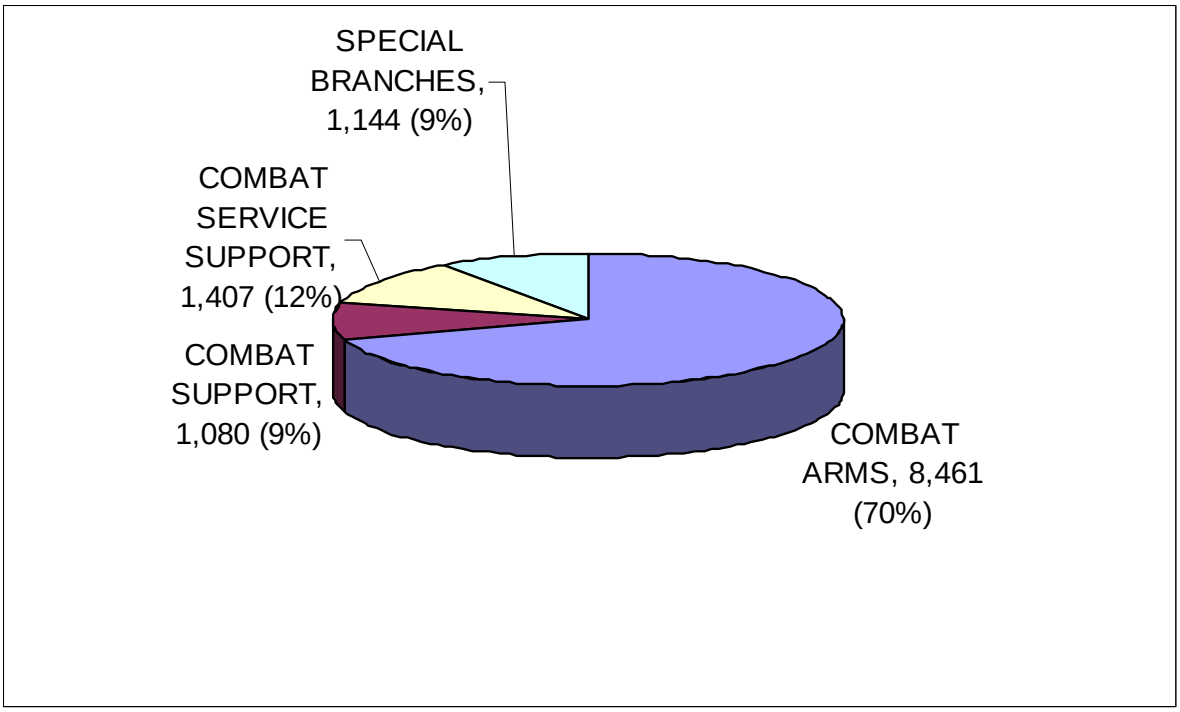
Figure 34 displays promotion rates for Army officers by prior enlistment status. About 56.2 percent of non-prior enlisted officers and 54 percent of prior enlisted officers were promoted to O-4. There seems to be only a small difference between promotion rates of officers who were prior enlisted and those who were not.



Source: Author tabulations based on DMDC data

Figure 34. Promotion Rates as of September 30, 2004 by Prior Enlistment Status for Army Officers Entering 1981-1995

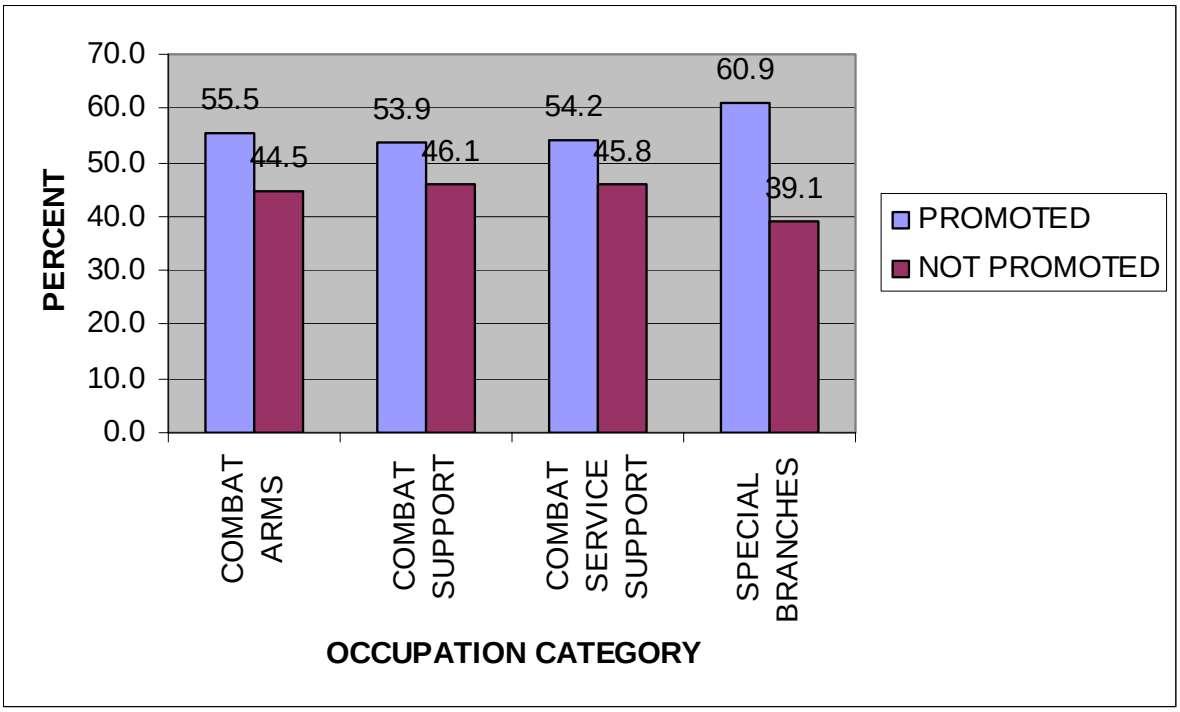
Figure 35 shows the number of Army officers by their occupational categories. The majority (70 percent) of the officers serve in the combat arms specialty, and they number 8,461. Combat service support officers comprise the second largest group and number 1,407 (12 percent). The number of officers in the special branches and combat support fields seems to be almost equal (1,144 and 1,080).



Source: Author tabulations based on DMDC data

Figure 35. Number and Percentage of Army Officers by Military Occupational Category

Figure 36 shows promotion rates by occupational categories. Special branches category has the highest promotion rate (60.9 percent). This category is followed by combat arms and combat service support with promotion rates of 55.5 percent and 54.2 percent, respectively. The lowest promotion rate is 53.9 percent for the combat support category.



Source: Author tabulations based on DMDC data

Figure 36. Promotion Rates as of September 30, 2004 by Military Occupational Category for Army Officers Entering 1981-1995

C. DATA LIMITATIONS

The main focus of this study is the effect of education level of officers on retention and promotion. However, in the data set, the education level of about 90,000 officers was miscoded or was unknown. The coding system for the education level variable was changed three times between 1981 and 2004. Some of the observations were lost in changes in the coding system. As a result, observations with miscoded or unknown education level have been deleted from the database for this study. While this deletion caused the number of observations used for analysis to decrease, it is assumed that the deleted observations were missing at random and their omission does not affect the validity of the study.

In order to provide some information on the representativeness of the retention and promotion samples, Table 7 compares and contrasts some of the characteristics of

Active Duty Officers in the Army in 2004 with those of officers used in this study. The actual values for Army officers are obtained from the Army's official web page.[101]

As seen in the table, there are no large differences between actual and sample percentages. The small differences that appear in the table may be attributable to time differences. The actual values show the percentages of officers who were on active duty in 2004, whereas the sample values show the percentages of all officers commissioned from 1981 to 2001 for retention analysis, and from 1981 to 1995 for promotion analysis.

Table 7. Characteristics of Army Officers from the "2004 Army Profile" and from the Retention and Promotion Samples in This Thesis

VARIABLE	US Army 2004*,102	Retention Sample	Promotion Sample
Education Level			
BA/BS (College)	58.60 percent	59.21 percent	68.49 percent
MA/PhD	40.00 percent	30.59 percent	30.75 percent
OTHER	1.400 percent	10.20 percent	0.76 percent
Marital Status			
Married	66 percent	74.71 percent	82.15 percent
Race/Ethnicity			
White	75.40 percent	79.06 percent	83.99 percent
Black	12.30 percent	11.56 percent	10.92 percent
Hispanic	5.00 percent	3.83 percent	1.78 percent
Other	7.30 percent	5.55 percent	3.32 percent
Gender			
Male	83.35 percent	84.34 percent	86.40 percent

*SOURCE: *Army Profile* from US Army Official Web Page and Author tabulations based on DMDC data

Education level is classified into four different categories for the analysis. These categories are not problematic in the retention model. However, after deleting invalid observations, there were only 20 officers with doctorate degrees in the data set used for

101 The US Army Official Web Page, *Army Profile*, <http://www.army.mil/references/FY04ArmyProfile.pdf#search=percent22militarypercent20officerspercent20percentpercent20percent20marriedpercent20withpercent20childrenpercent22>, (accessed February 13, 2007).

102 Ibid.

promotion analysis, which is too few. For this reason, officers with doctorate degrees are combined with the master's degree holders for survival analysis.

Some variables that were used in previous studies on the effects of education level on retention and/or promotion were not available in the data set and could not be used in the analysis. These variables include the college grade point average of an officer, performance reports, whether an officer separated voluntarily, the quality of the college from which the officer graduated, awards received, and the officer's alma mater for graduate education (military or civilian).

Survival analysis is used as the empirical approach for both retention and promotion models. Survival analysis requires using a duration variable as the dependent variable. Two different duration variables are used for the two models in this study. For the retention model, YEARSSERVED is used and it is calculated by counting active duty service years. However, in the data set, some of the observations have gaps in pay grade history, and these observations are deleted. For the promotion analysis, the duration variable is TIMEYRS, which is calculated by counting valid years until an officer becomes a major or until the censoring year. Some of the observations had incorrect values for this variable and it was necessary to delete these observations.

D. CHAPTER SUMMARY

The number of observations for retention analysis is 45,228, promotion analysis uses 12,092 observations. For the promotion model, only officers who served at least eight years are included in the analysis. Thus, officers commissioned after 1996 are eliminated for the promotion analysis. Censored values and the total number of observations for each model are summarized in Table 8. Of all the officers who entered commissioned service between 1981 and 2001, 26.52 percent had left the Army by September 2004. Of all the officers commissioned between 1981 and 1995, 55.76 percent had been promoted to O-4 (MAJOR) by the same date. For the retention model, censored observations are those who were still on active duty on September 30, 2004. For the

promotion model, the censored observations are those who were not promoted by September 30, 2004, or who left the Army by that date after serving at least eight years but not being promoted to O-4.

Table 8. Number of Observations and Censored Values Used for Analysis

Type of Analysis	Total Observations	Separated (promoted) by Sep 30, 2004	Censored	Percent censored
Retention	45,228	11,996	33,232	73.48
Promotion	12,092	6,742	5,350	44.24

Source: Author tabulations based on DMDC data

Based on the preliminary analysis presented in this chapter, advanced education seems to be positively correlated with both the retention and promotion of Army officers. Officers with master's degrees and doctorate degrees have the lowest separation rates. In addition, officers with baccalaureate degrees have the lowest promotion rates among the four education level categories.

VI. RESULTS OF SURVIVAL ANALYSIS

Two different outcomes are analyzed in this study - the retention of Army officers and the promotion of Army officers. The chapter therefore addresses the analyses in two different subsections. It first discusses the retention analysis. This is followed by a discussion of the promotion results. In both models, three SAS procedures are used - PROC LIFETEST, PROC LIFEREG and PROC PHREG. The chapter first discusses PROC LIFETEST results, since they show whether there are differences among survival curves (promotion curves) of officer groups with different education levels. This is followed by a display of the PROC LIFEREG results for parametric duration analysis. Finally, there is an explanation of the PROC PHREG results for Cox proportional hazard models. The hypothesized and observed effects are compared in the last part of the chapter.

A. RETENTION ANALYSIS

1. Analysis of Survival Patterns

The PROC LIFETEST procedure in SAS uses both the Kaplan-Meier method and the life-table method in order to find estimates of survivor functions. In fact, the two methods yield the same results. The Kaplan-Meier method gives results for each individual in the data set, whereas the life-table method gives results from grouping the observations into time intervals. Both methods give the probability that a person will survive until the time $t+1$, given that he or she has survived until the time t, as well as the probability of not surviving (separate or not promote) during the same time frame.[103] The life-table method produces estimates and plots of the hazard function.[104] For this reason, this study uses the life-table method.

Table 9 shows the life-table survival estimates, in which, officers are grouped in five-year intervals. The first two columns show the intervals by years. The third and

[103] Paul D.Allison, *Survival Analysis Using SAS,* 29-41.

[104] Ibid., 41.

fourth columns show the number who separate and who are censored. The effective sample size is the number of officers who survived to that interval, but it is calculated at the mid-point. Since the officers are grouped in five-year intervals, it is unknown who left in which year. Thus, the value of the effective sample size is calculated at the mid-point. This assumes that the distribution of failures is normal in that interval. So, every observation that is censored within an interval is treated as if it were censored at the mid-point of the interval.[105] Since censored cases are at risk for half of the interval, they only count for half in figuring the effective sample size.[106] For example, the effective sample size for the first interval is 45,228 – (1,013/2) = 44,721.5.

Table 9. Life - Table Survival Estimates (Retention Model)

Lower Interval	Upper Interval	Number Failed	Number Censored	Effective Sample Size	Conditional Probability of Failure	Conditional Probability Standard Error	Survival	Failure
0	5	3351	1013	44721.5	0.0749	0.00124	1	0
5	10	5372	12647	34540.5	0.1555	0.00195	0.9251	0.0749
10	15	1780	9291	18199.5	0.0978	0.0022	0.7812	0.2188
15	20	575	8052	7748	0.0742	0.00298	0.7048	0.2952
20	25	918	2229	2032.5	0.4517	0.011	0.6525	0.3475

Table 9. Life - Table Survival Estimates (Retention Model) (continued)

Lower Interval	Upper Interval	Survival Standard Error	PDF	PDF Standard Error	Hazard	Hazard Standard Error
0	5	0	0.015	0.000249	0.015569	0.000269
5	10	0.00124	0.0288	0.000363	0.033728	0.000459
10	15	0.00209	0.0153	0.000346	0.020567	0.000487
15	20	0.00255	0.0105	0.000421	0.015415	0.000642
20	25	0.00316	0.0589	0.00147	0.116683	0.003684

Source: Author

The conditional probability of failure in column six shows the probability that an officer is going to leave in an interval, given that he or she made it to the beginning of that interval. For example, the probability of an officer leaving the Army between the

[105] Allison, 44.

[106] Ibid.

sixth and tenth years (second interval) is 0.1555, given that he or she is still in the service at the beginning of the sixth year. This is calculated as (number failed / effective sample size).[107] The survival column (column 8) shows that the event occurs at a time later than or equal to the start time of each interval.[108] For example, the probability that an officer will not leave the Army until year 5 is 0.9251. In other words, the probability that an officer continues to serve (survives) until year 5 is 0.9251. The failure column (column 9) is calculated by subtracting the survival column from one. This column shows the opposite of the survival column, that is, it shows the probability of an event occurring by the beginning of that interval. For example, the probability that an officer will leave by the beginning of the second interval (year 5) is 0.0749.

PDF shows the estimate of the Probability Density Function at the mid-point of that interval. The Hazard column shows the estimate of the hazard function at the midpoint. For each statistic presented in the Life-Table estimates, the standard errors are also shown next to each estimate.[109]

The PROC LIFETEST procedure in SAS also gives the censored and uncensored values. As seen in Table 10, 11,996 officers out of 45,228 left the Army by the end of the observation period (September 30, 2004).

Table 10. Censored (Stay) and Uncensored (Leave) Values

Summary of the Number of Censored and Uncensored Values			
Total	**Failed**	**Censored**	**Percent Censored**
45,228	11,996	33,232	73.48

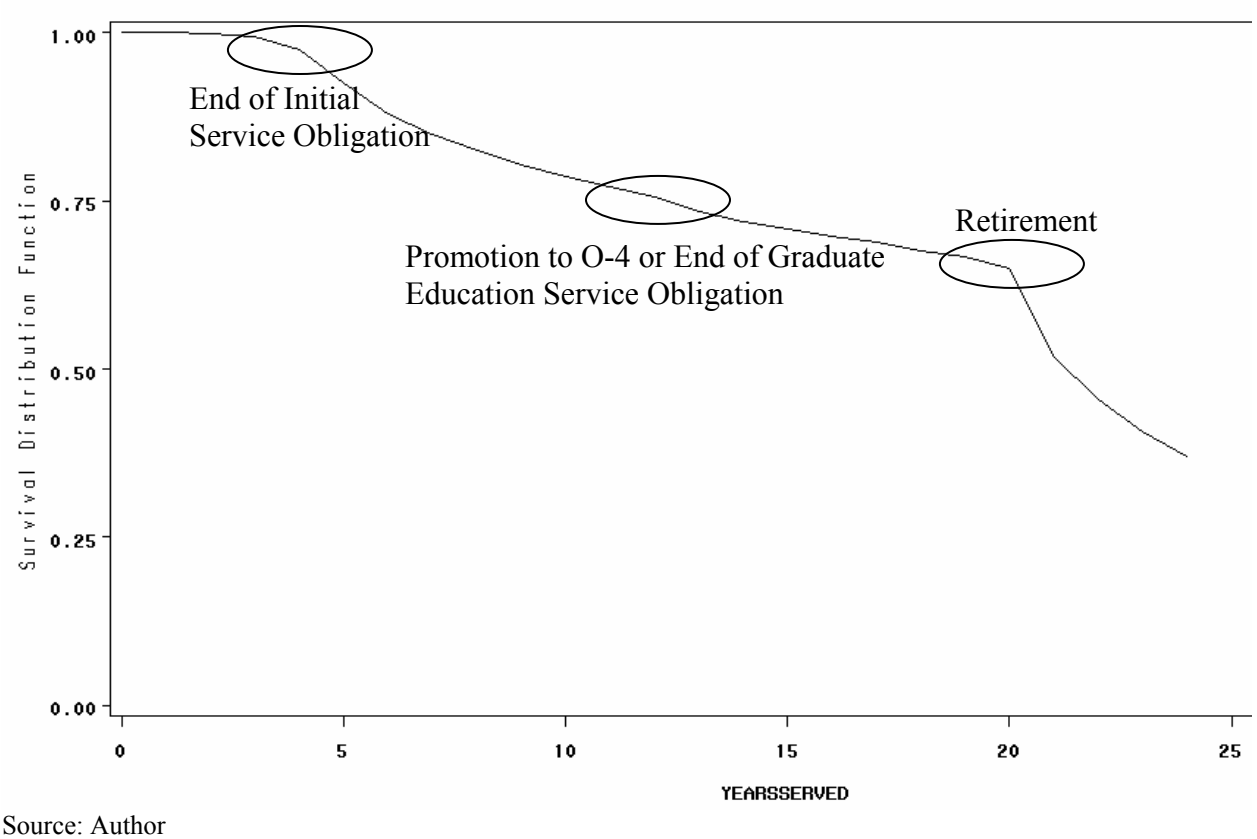
Source: Author

[107] Allison, 44.

[108] Ibid., 45.

[109] Ibid., 46.

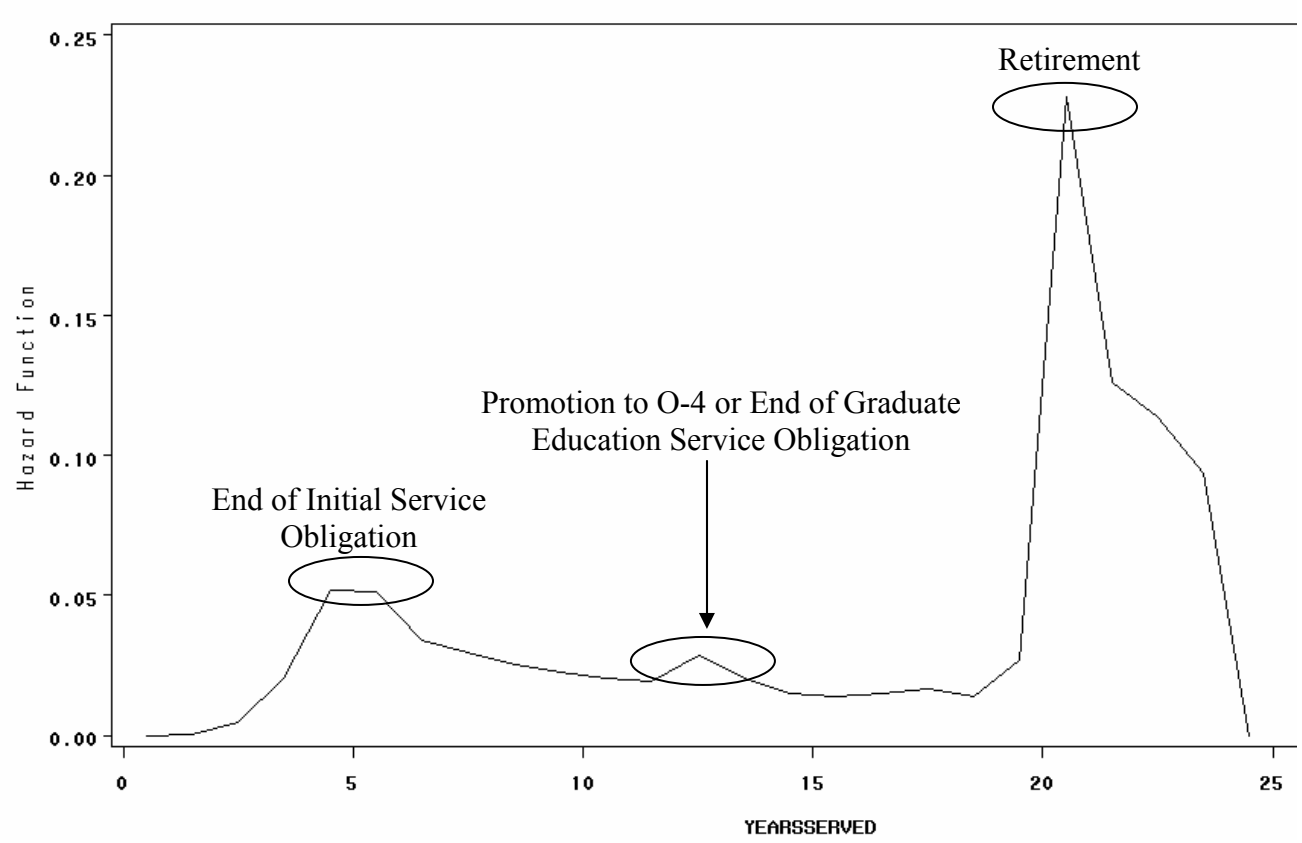
The survivor functions can be plotted in a graph by using the LIFETEST procedure in SAS. Figure 37 shows a plot of the survival function for Army officers. As seen in the figure, the survival function is flat until the fourth year, indicating that almost everybody continues serving in the Army up to that year, which is the end of the initial service obligation for most officers. After that year the function becomes steeper. The function is then almost flat until the twelfth to thirteenth year. After that it becomes slightly steeper. These years mark both the promotion point to major for most officers, and end of service obligation related to graduate education. Then the function continues, becoming flatter until the twentieth year, where it has a sharp decrease. The twentieth year is the retirement eligibility point for officers. Thus, the function falls steeply showing the separation (retirement) behavior of officers.



Source: Author

Figure 37. Survival Distribution Function of Army Officers (Retention Model)

Figure 38 displays the plot of the hazard function for Army officers. As seen in the figure, the hazard of leaving the service increases in the fourth year and remains the same until the sixth year. Again, this time period is the end of the initial service obligation. There is an increase in the hazard function in the twelfth to thirteenth years, which is both the promotion point for officers and the end of service obligation related to graduate education. Finally, there is a sharp increase in the hazard function in the twentieth year, which is retirement point.



Source: Author

Figure 38. Hazard Function of Army Officers (Retention Model)

The main focus of this study is the effect of education level on the retention and promotion of Army officers. Thus, one of the research questions is to find out if there are any differences among the survival or hazard functions of officers with different

education levels. Table 11 shows the number of failed (separated) and censored (still in service in 2004) officers, and the percent of censored values for officers with four different education levels.

Table 11. Summary of the Number of Censored (Stay) and Failed (Leave) Observations (Retention)

EDUCATION LEVEL	Total	Failed	Censored	Percent Censored	Log-Rank	Wilcoxon
COLLEGE	26781	8588	18193	67.93	2982	102120000
MASTER'S DEGREE	13403	1826	11577	86.38	279	7438692
DOCTORATE DEGREE	432	98	334	77.31	-79	-1889177
PROFESSIONAL DEGREE	4612	1484	3128	67.82	-3182	-107700000

Source: Author

Table 12 displays the results of testing the null hypothesis that the survival functions of officers with different education levels are the same. The PROC LIFETEST procedure gives three statistics for testing this null hypothesis -- the log-rank test (Mantel-Haenszel test), the Wilcoxon test, and the likelihood-ratio test. The Wilcoxon test gives more importance to earlier time periods. Thus, it is less sensitive to differences in later time periods than the log-rank test. The Wilcoxon test is more powerful in situations where event times have log-normal distributions. The third method is the likelihood-ratio test, which assumes an exponential distribution.[110] As seen in Table 12, one can reject the null hypothesis at all usual levels using all of these tests, and conclude that survival functions of officers differ with their education levels.

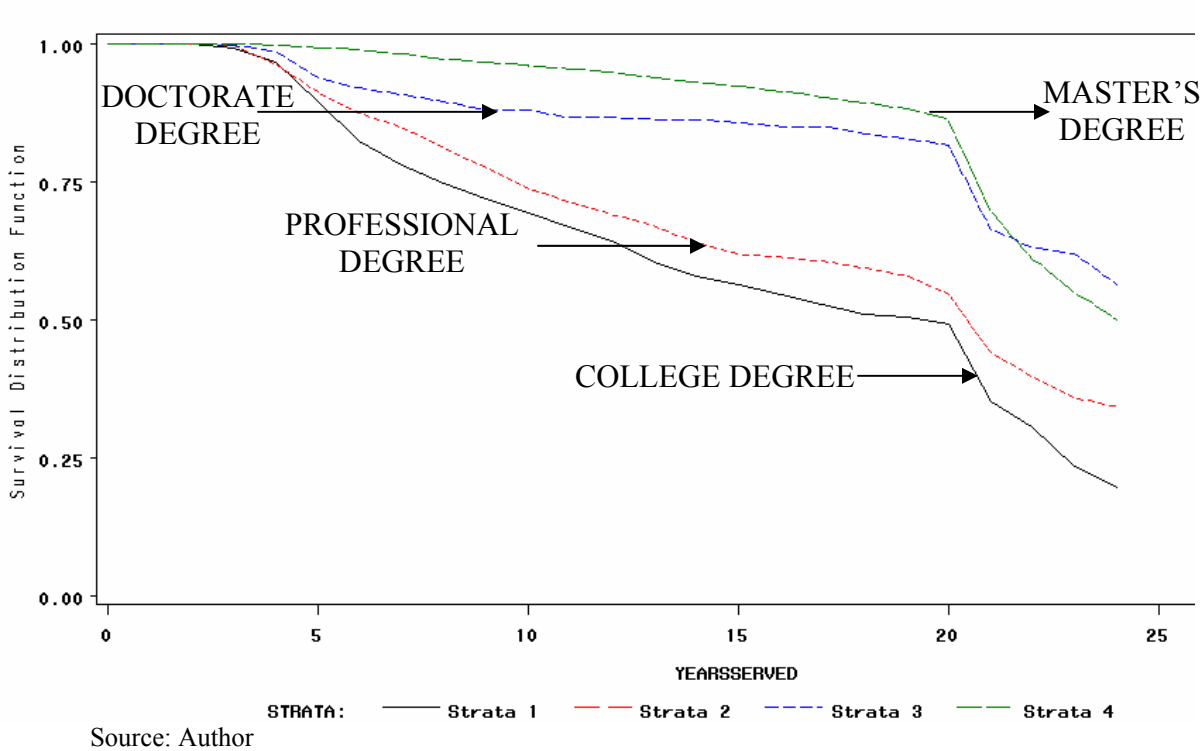
Table 12. Test Statistics for the Equality in Survival Behavior of Officers with Different Education Levels

Test of Equality over Strata			
Test	**Chi-Square**	**DF**	**Pr > Chi Square**
Log-Rank	4249.1439	3	<.0001
Wilcoxon	4002.3154	3	<.0001
-2Log(LR)	3975.8201	3	<.0001

Source: Author

[110] Allison, 36-39.

Figure 39 displays the survival functions of officers with different educational levels. During the first four years there is no difference between the survival functions of officers, due to the service obligation for all officers. As seen in the figure, college graduates have the lowest survival curve. Officers with master's degrees have the highest survival functions, with the exception of the last 2-3 years.

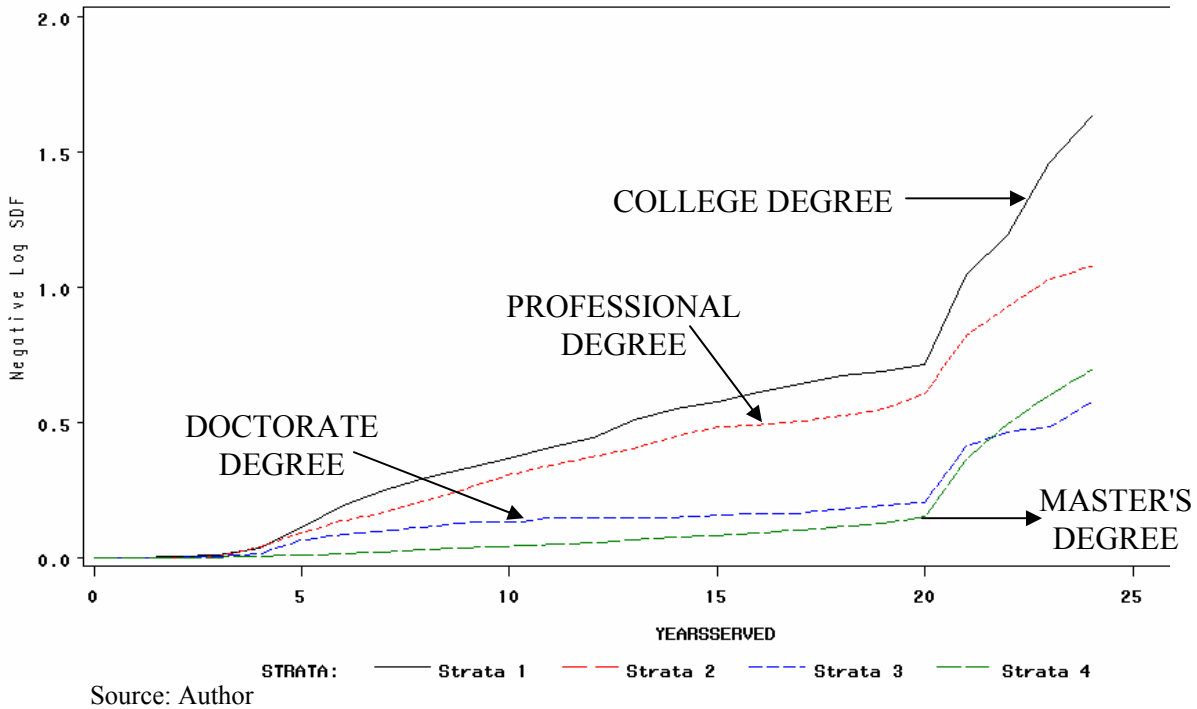


Source: Author

Figure 39. Survival Distribution Function of Army officers with Different Education Levels

College graduates and professional degree holders have approximately similar survival functions, whereas officers with master's and doctorate degrees have very similar survival curves; however, there is a great difference between the survival functions of officers with baccalaureate or professional degrees and officers with master's or doctorate degrees. In all groups, there is a sharp decrease in survival functions at year 20, which is the retirement point.

The PROC LIFETEST procedure in SAS also produces the log-survival plot. Examining this plot is useful because it gives information about the trend in the survival function. That is, it shows whether the hazard is constant, increasing or decreasing over time. Figure 40 displays the log-survival plot for officers with different education levels. The graphs for all groups increase at an increasing rate after the twentieth year of service, showing that the hazard of separating from the Army for officers increases with time. Nevertheless, until the twentieth year, the hazard functions are almost constant, showing that the hazard of leaving increases at a constant rate until that year. However, the sharpest increase is observed for officers with baccalaureate degrees. The second sharpest increase is observed for officers with professional degrees. The hazard plots of officers with master's and doctorate degrees are almost flat, showing that their separation rates increase at a small constant rate over time until the twentieth year.



Source: Author

Figure 40. Log-Survival Plot for Army Officers with Different Education Levels

2. Results of Parametric Regression Models

The LIFEREG procedure calculates parametric regression estimates using the maximum likelihood method. There are five different distributions used in PROC LIFEREG for survival analysis -- lognormal, Weibull, exponential, gamma and log-logistic. These five distributions have different implications for hazard functions, which may lead to important differences in interpretation.[111]

Table 13 displays the results of the LIFEREG procedure for all five distributions. As seen in Table 13, the significance of coefficients changes from model to model. For example, although the coefficient of ROTCSCHOLAR is significant at all usual levels using the WEIBULL and EXPONENTIAL distributions, it is not significant at any usual level in any of the other distributions. The signs of the coefficients show the direction of the relationship. In other words, the signs show the effects of explanatory variables on the retention of officers. Parameter estimates are not interpreted directly -- a conversion is required, which is explained later in this chapter. The parameter estimates also change from distribution to distribution, indicating that the magnitude of the effects of independent variables change from distribution to distribution.

Of these five distributions, one fits the data set best. The goodness of fit can be evaluated and compared in two different ways -- using log-likelihoods and with a graphical method. Likelihood ratio statistics can be used to compare nested models. A model is nested within another model if that model can be obtained by imposing restrictions on the parameters in the second model. The exponential model is nested within the Weibull and gamma models. Furthermore, the Weibull and log-normal models are nested within the gamma model. Taking the differences between nested models and multiplying by two gives the likelihood-ratio chi-square statistics. Lower magnitudes correspond to better fits.[112]

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[111] Allison, 66.

[112] Allison, 88-91.

Table 13. Results of PROC LIFEREG Procedure

	LNORMAL		WEIBULL		EXPONENT		GAMMA		LLOGISTIC	
Variable	Estimate	ChiSq	Estimate	ChiSq	Estimate	ChiSq	Estimate	ChiSq	Estimate	ChiSq
Intercept	3.17591	<.0001	3.15969	<.0001	3.32963	<.0001	3.15195	<.0001	3.09786	<.0001
GRADUATEDEGREE	0.29837	<.0001	0.3038	<.0001	0.87643	<.0001	0.25563	<.0001	0.30986	<.0001
DOCTORATEDEGREE	0.2421	<.0001	0.2512	<.0001	0.72398	<.0001	0.21464	<.0001	0.25516	<.0001
PROFESSIONALDEGREE	0.08445	<.0001	0.08796	<.0001	0.24055	<.0001	0.07891	<.0001	0.08835	<.0001
FEMALE	-0.0924	<.0001	-0.0993	<.0001	-0.2654	<.0001	-0.0572	<.0001	-0.1029	<.0001
MARRIED	0.14507	<.0001	0.13033	<.0001	0.35282	<.0001	0.13753	<.0001	0.14681	<.0001
ENTRYAGE	-0.0104	<.0001	-0.0088	<.0001	-0.026	<.0001	-0.0113	<.0001	-0.0099	<.0001
BLACK	0.08159	<.0001	0.08909	<.0001	0.23851	<.0001	0.04403	<.0001	0.0923	<.0001
HISPANIC	0.06182	0.0001	0.05736	0.0004	0.1581	0.0019	0.0403	0.0096	0.06569	<.0001
OTHERRACE	0.04522	0.0006	0.04632	0.0002	0.12455	0.0017	0.03894	0.0027	0.04838	0.0003
ROTCSCHOLAR	0.00722	0.4324	0.0274	0.0011	0.08621	0.0011	-0.0066	0.4825	0.01359	0.128
ROTCNONSCHOLAR	0.11418	<.0001	0.13958	<.0001	0.38208	<.0001	0.0675	<.0001	0.13362	<.0001
OTHERSOURCE	0.07672	<.0001	0.10587	<.0001	0.28672	<.0001	0.03429	0.0039	0.09782	<.0001
PREENLIST	0.0616	<.0001	0.06947	<.0001	0.18508	<.0001	0.05258	<.0001	0.06988	<.0001
COMBATSUPPORT	-0.0431	0.0003	-0.0479	<.0001	-0.1424	<.0001	-0.0213	0.07	-0.0461	<.0001
COMBATSERVICESUPPORT	-0.0365	0.0002	-0.0331	0.0005	-0.088	0.0034	-0.0275	0.0042	-0.0369	0.0002
SPECIALBRANCHES	-0.0743	<.0001	-0.0778	<.0001	-0.2176	<.0001	-0.0579	<.0001	-0.0812	<.0001
ENTRYYR82	0.05522	0.0893	0.04389	0.097	0.18781	0.0241	0.04819	0.1711	0.05022	0.084
ENTRYYR83	0.06672	0.0526	0.05378	0.0615	0.28903	0.0014	0.05198	0.1558	0.05869	0.0596
ENTRYYR84	0.13837	<.0001	0.12763	<.0001	0.58947	<.0001	0.10409	0.0007	0.12833	<.0001
ENTRYYR85	0.3691	<.0001	0.42106	<.0001	1.59731	<.0001	0.24448	<.0001	0.39227	<.0001
ENTRYYR86	0.32595	<.0001	0.38702	<.0001	1.62074	<.0001	0.19962	<.0001	0.35092	<.0001
ENTRYYR87	0.25323	<.0001	0.29926	<.0001	1.46313	<.0001	0.13871	<.0001	0.26945	<.0001
ENTRYYR88	0.1628	<.0001	0.19477	<.0001	1.25232	<.0001	0.05289	0.0594	0.17316	<.0001
ENTRYYR89	0.01344	0.6136	0.0374	0.1248	0.91118	<.0001	-0.0877	0.0013	0.02013	0.4254
ENTRYYR90	-0.0826	0.0017	-0.0611	0.0096	0.74174	<.0001	-0.1753	<.0001	-0.0787	0.0015
ENTRYYR91	-0.1423	<.0001	-0.1249	<.0001	0.68509	<.0001	-0.2371	<.0001	-0.1395	<.0001
ENTRYYR92	-0.2089	<.0001	-0.1897	<.0001	0.63989	<.0001	-0.3107	<.0001	-0.2032	<.0001
ENTRYYR93	-0.3088	<.0001	-0.283	<.0001	0.52854	<.0001	-0.4212	<.0001	-0.2993	<.0001
ENTRYYR94	-0.41	<.0001	-0.3748	<.0001	0.42634	<.0001	-0.5351	<.0001	-0.3939	<.0001
ENTRYYR95	-0.5655	<.0001	-0.5234	<.0001	0.18943	0.0034	-0.6963	<.0001	-0.5473	<.0001
ENTRYYR96	-0.7594	<.0001	-0.6944	<.0001	-0.0888	0.1515	-0.9062	<.0001	-0.7339	<.0001
ENTRYYR97	-0.9465	<.0001	-0.8566	<.0001	-0.3114	<.0001	-1.115	<.0001	-0.9126	<.0001
ENTRYYR98	-1.0723	<.0001	-0.9737	<.0001	-0.4124	<.0001	-1.2764	<.0001	-1.0243	<.0001
ENTRYYR99	-1.098	<.0001	-1.0164	<.0001	-0.2861	<.0001	-1.3473	<.0001	-1.0429	<.0001
ENTRYYR00	-1.1977	<.0001	-1.1222	<.0001	-0.2463	0.0012	-1.5236	<.0001	-1.145	<.0001
ENTRYYR01	-1.2084	<.0001	-1.1066	<.0001	0.24746	0.0234	-1.5355	<.0001	-1.1372	<.0001

Source: Author

In the graphical approach, a graph of the survivor function is drawn and then that graph is compared with one drawn as a straight line originating at zero. This line is the survival function plotted against time with zero residuals, meaning that all observations are on that line and there are no deviations. Thus, the distribution that deviates least from the straight line is the best.

The log likelihoods for five different models are shown in Table 14. If chi-square statistics are calculated by using these log likelihoods as explained above, then the results in Table 15 are obtained. The exponential and Weibull models are rejected, and the Log-logistic model is rejected as well. As a result, it can be concluded that both the log-normal and gamma models fit the data very well.

Table 14. Log Likelihoods of All Distributions (Retention Model)

Name of Distribution	Log Likelihood
LOG-NORMAL	-22015.58215
WEIBULL	-22897.95334
EXPONENTIAL	-29017.257
GAMMA	-21636.30682
LOG-LOGISTIC	-22477.4002

Source: Author

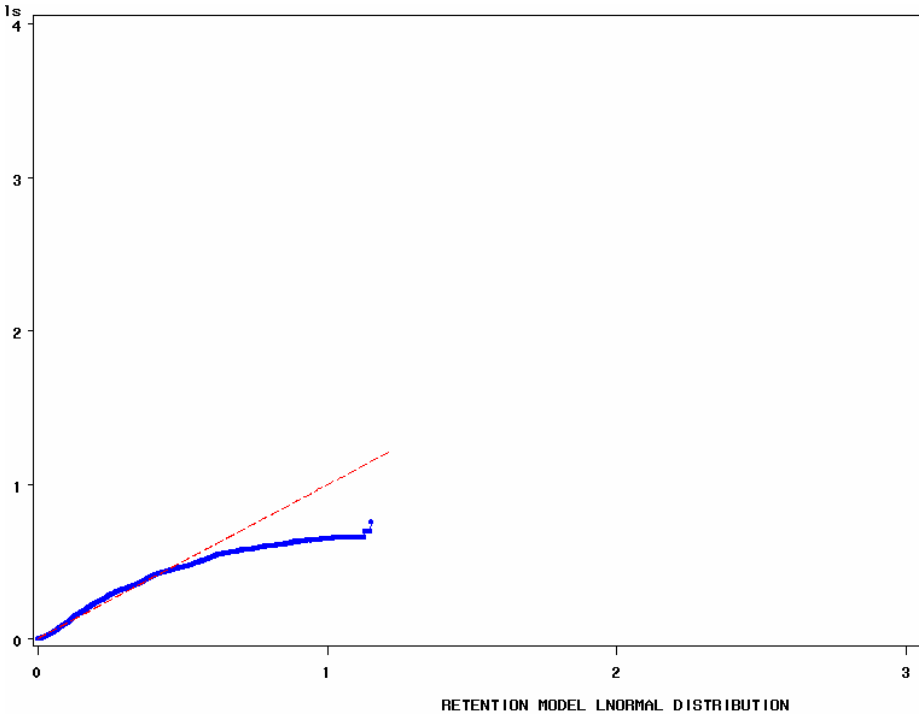
Table 15. Chi-Square Statistics within Nested Models

Comparison	Chi-Square
Exponential vs. Weibull	12238.60732
Exponential vs. Gamma	14761.90036
Weibull vs. Gamma	2523.29304
Log-Normal vs. Gamma	758.55066
Log-Logistic vs. Gamma	1682.18676

Source: Author

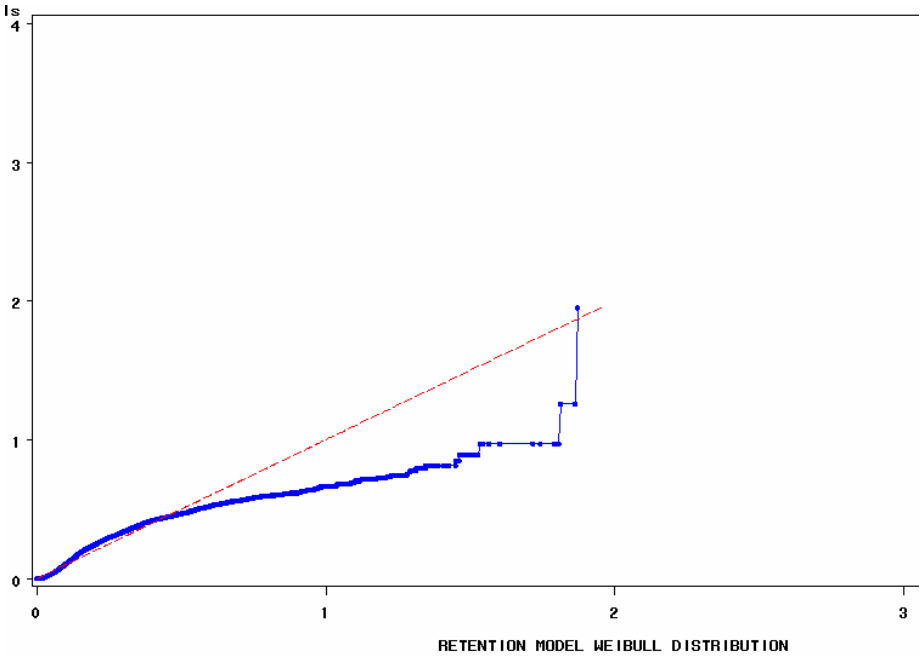
One can check this result with the second method, which is the graphical approach. Figures 41 through 45 plot the residuals for all distributions. As seen in the figures, the gamma model fits best, as it has the least deviation from the straight line.

Since the gamma distribution is judged the best using the graphical method and is one of the two best methods using the log-likelihood method, this distribution will be used for the retention analysis of Army officers.



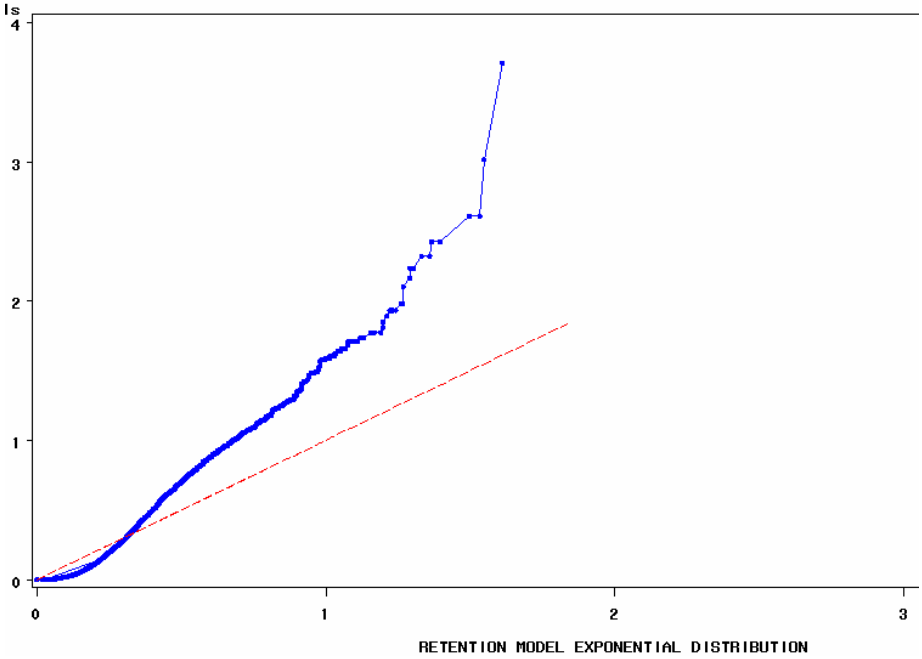
Source: Author

Figure 41. Residual Plot - Retention Model (Log-normal Distribution)



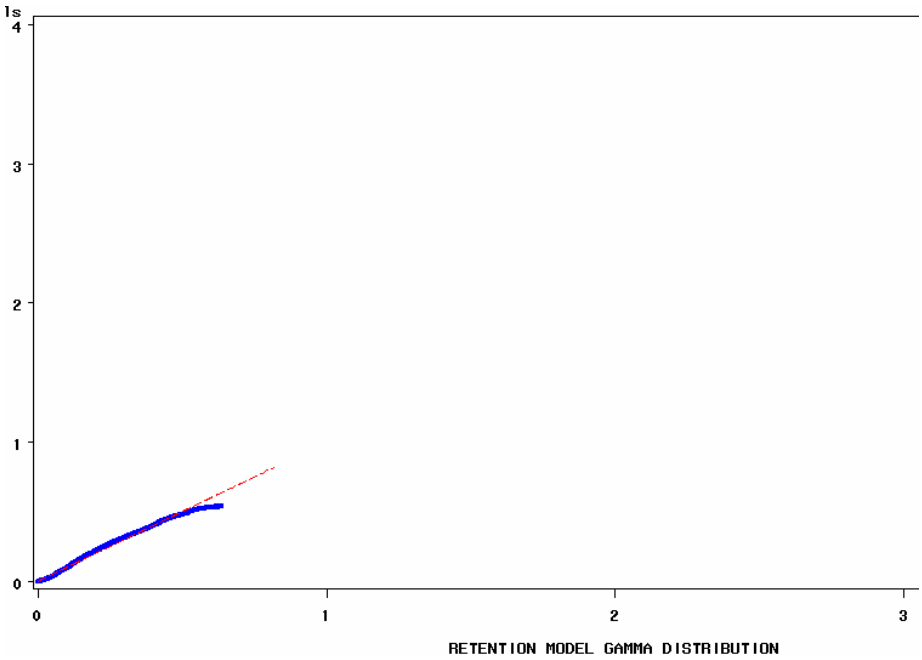
Source: Author

Figure 42. Residual Plot - Retention Model (Weibull Distribution)



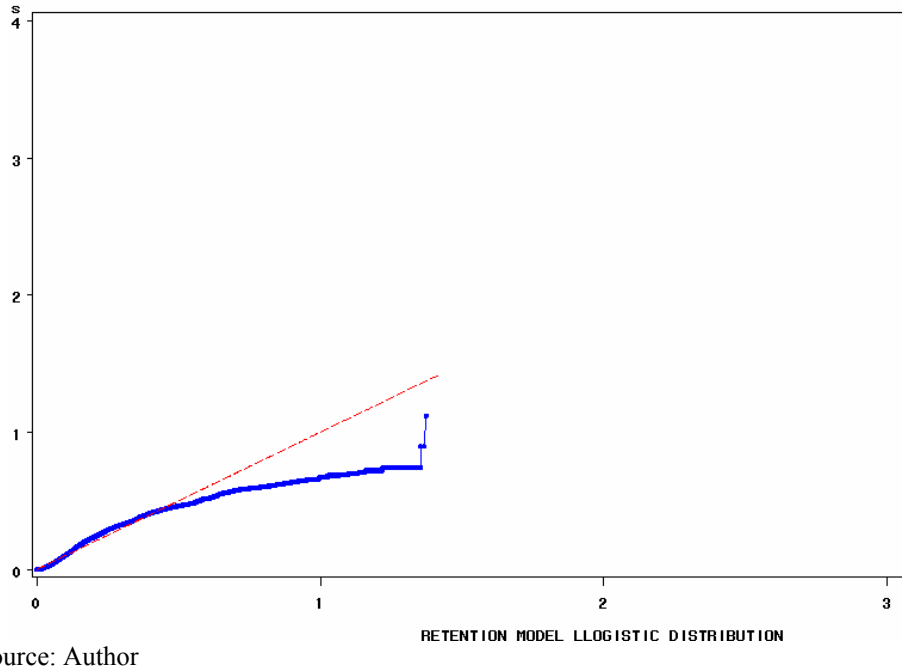
Source: Author

Figure 43. Residual Plot - Retention Model (Exponential Distribution)



Source: Author

Figure 44. Residual Plot - Retention Model (Gamma Distribution)



Source: Author

Figure 45. Residual Plot - Retention Model (Log – logistic Distribution)

Table 13 displays the LIFEREG procedure results for all distributions. Table 16 displays the LIFEREG procedure results for the gamma distribution, including estimated effects. The *Effect* column in Table 16 is produced by using the *Estimate* column in the same table. For binary variables, e^{β} produces the estimated mean difference in survival times for two groups.[113] For example the coefficient of GRADUATEDEGREE is 0.25563. Thus, $e^{0.22563}=1.2913$. This means that officers with master's degrees are estimated to survive 29.13 percent longer than college graduate officers, controlling for the other factors. For continuous variables, $100*(e^{\beta}-1)$ gives the percent increase (decrease) in the estimated survival time for each one unit increase in the variable.[114] As a result, the *Effect* column in Table 16 shows the effect of variables in percentage points.

The results show that all levels of advanced education have positive effects on the retention of Army officers. The effects are significant at all usual levels, as seen in the tables (p-values). The expected survival time of an officer with a master's degree is 29.13 percent greater than that of an officer who has baccalaureate degree, accounting for other covariates. The expected survival time of an officer with doctorate degree is 23.94 percent greater, and the expected survival time of an officer with a professional degree is 8.21 percent more than that of an officer who has baccalaureate degree, accounting for other covariates.

For the demographic variables, being married and being in a minority group have a positive effect on service times, whereas being female and each additional year in entry age have a negative effect. All these effects are statistically significant at all usual levels. Service time of married officers is estimated to be 14.74 percent longer than for single officers, ceteris paribus. The expected survival time of black officers is 4.50 percent greater, of Hispanic officers is 4.11 percent greater and of officers of other minority groups is 3.97 percent greater, respectively, than that of white officers. Service time of female officers is expected to be 5.56 percent less than for male officers, when

[113] Allison, 65.

[114] Ibid.

controlling for other factors. Each additional year increase in entry age decreases the expected survival time of officers by 1.12 percent, controlling for other covariates

Commissioning source variables have statistically significant effects on the retention behavior of officers with the exception of ROTCSCHOLAR. Thus, compared with USMA graduates, the survival time of officers whose commissioning source is ROTC non-scholarship is expected to be 6.98 percent greater, and the survival time of officers who are commissioned through other sources is expected to be 3.49 percent longer than that of USMA graduates, ceteris paribus. Having an ROTC scholarship as a commissioning source has no significant effect on the survival times of officers. Having served as enlisted before being commissioned as an officer increases service time by 5.40 percent, and this result is significant at all usual levels.

Table 16. Results of Gamma Distribution (Retention Model)

Variable	Estimate	Effect (%)	Chi-Square	Pr > ChiSq
Intercept	3.15195		7555.2641	<.0001
GRADUATEDEGREE	0.25563	29.13	904.5559	<.0001
DOCTORATEDEGREE	0.21464	23.94	44.52	<.0001
PROFESSIONALDEGREE	0.07891	8.21	34.3136	<.0001
FEMALE	-0.05717	-5.56	43.3365	<.0001
MARRIED	0.13753	14.74	372.7108	<.0001
ENTRYAGE	-0.01126	-1.12	86.1651	<.0001
BLACK	0.04403	4.50	20.8966	<.0001
HISPANIC	0.0403	4.11	6.7149	0.0096
OTHERRACE	0.03894	3.97	9.0089	0.0027
ROTCSCHOLAR	-0.0066027	--	0.4931	0.4825
ROTCNONSCHOLAR	0.0675	6.98	47.9589	<.0001
OTHERSOURCE	0.03429	3.49	8.3131	0.0039
PREENLIST	0.05258	5.40	55.0446	<.0001
COMBATSUPPORT	-0.02128	-2.11	3.2836	0.07
COMBATSERVICESUPPORT	-0.02754	-2.72	8.1974	0.0042
SPECIALBRANCHES	-0.05786	-5.62	29.3916	<.0001

Source: Author

All occupational categories in the model have a significantly negative effect on retention, compared with combat arms. The expected service time of officers serving in combat support fields is 2.11 percent lower than that of officers serving in combat arms fields, controlling for other factors. The service time of officers serving in combat service support fields is 2.72 percent lower, and the service time of officers serving in special branch fields is 5.62 percent lower than that of officers serving in combat arms fields. The result for the combat support category is significant at 0.10 level and results for the other occupational categories are significant at all usual levels.

Officers commissioned from 1984 to 1988 are found to have longer survival times, whereas officers commissioned after 1988 are found to have shorter survival times, when compared to officers commissioned in 1981. This shows the survival trend in the Army, which is generally decreasing on average. Commissioning years 1982 and 1983 have no significant effect on the retention of officers (see Table 13).

3. Results of Estimating Cox Regression Models

The same variables used for the LIFEREG procedure are used in the PHREG procedure. Unlike PROC LIFEREG, the Cox proportional hazard model does not necessitate choosing any particular probability distribution to represent survival times. Thus, the model specified in PHREG is used directly for the analysis. Another advantage of using this regression method is that it allows the use of time-dependent independent variables, which may change their values during the observation period.[115]

To test the global null hypothesis, which is that all the coefficients are equal to zero (the explanatory variables have no effect on the survival times), the PHREG procedure calculates three statistics -- likelihood ratio, score test and Wald test. The results of these tests are given in Table 17. All of the test results have a p-value of less than 0.0001, showing that at least one of the coefficients is not equal to zero, and at least one of the explanatory variables has an effect on the hazard function.

[115] Allison, 111,112.

Table 17. Global Test Statistics for the Retention Model for the Null Hypothesis that All Coefficients are Equal to Zero

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	14335.2664	36	<.0001
Score	12379.6962	36	<.0001
Wald	8446.804	36	<.0001

Source: Author

Table 18 displays the results of the PHREG procedure. There is no intercept estimate in the results, which is a characteristic of partial likelihood estimates.[116] The signs of the parameter estimates show the opposite of the effect on the survival function. The reason is that PROC PHREG results are in log-hazard format. The hazard ratio, in the last column, is e^{β}.

The effect of the advanced education variables on the probability of continuation or separation of officers is found to be positive, as in the LIFEREG procedure. That is, the probability of separation of officers with advanced degrees is less than for college graduates. Coefficients of all of the education variables are significant at all usual levels. Since all the hazard ratios associated with education variables are less than one, they indicate that the hazard of leaving the service for officers with advanced education degrees is less than the base case, which is a baccalaureate degree. An officer with a master's degree has a hazard of leaving that is 38.3 percent of that of an officer with just a college degree (base case) (61.7 % less), controlling for the other variables. The hazard of separation for an officer with a doctorate degree is 55.6 percent less than that of an officer with a college degree, ceteris paribus. An officer with a professional degree has a hazard of leaving the service that is 75.6 percent of that of a college graduate, when controlling for other factors.

116 Allison, 117.

Table 18. Results of the PHREG Procedure for the Retention Model

Variable	Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
GRADUATEDEGREE	-0.9594	0.02996	1025.465	<.0001	0.383
DOCTORATEDEGREE	-0.81274	0.10492	60.0008	<.0001	0.444
PROFESSIONALDEGREE	-0.28007	0.03937	50.598	<.0001	0.756
FEMALE	0.30271	0.02481	148.8544	<.0001	1.354
MARRIED	-0.39991	0.01997	401.1292	<.0001	0.67
ENTRYAGE	0.02884	0.00374	59.3616	<.0001	1.029
BLACK	-0.27624	0.03235	72.8932	<.0001	0.759
HISPANIC	-0.17765	0.05085	12.2031	0.0005	0.837
OTHERRACE	-0.14605	0.03969	13.5399	0.0002	0.864
ROTCSCHOLAR	-0.07193	0.02642	7.4109	0.0065	0.931
ROTCNONSCHOLAR	-0.41193	0.02996	189.0655	<.0001	0.662
OTHERSOURCE	-0.30279	0.03674	67.9276	<.0001	0.739
PREENLIST	-0.20984	0.02269	85.5416	<.0001	0.811
COMBATSUPPORT	0.14336	0.03518	16.6093	<.0001	1.154
COMBATSERVICESUPPORT	0.10048	0.03008	11.1578	0.0008	1.106
SPECIALBRANCHES	0.24152	0.03148	58.8469	<.0001	1.273
ENTRYYR82	-0.22423	0.08326	7.2536	0.0071	0.799
ENTRYYR83	-0.2409	0.09123	6.9726	0.0083	0.786
ENTRYYR84	-0.42693	0.0821	27.0401	<.0001	0.653
ENTRYYR85	-1.3102	0.13424	95.2629	<.0001	0.27
ENTRYYR86	0.02865	0.12639	0.0514	0.8207	1.029
ENTRYYR87	0.53281	0.12413	18.4243	<.0001	1.704
ENTRYYR88	0.91714	0.11623	62.2592	<.0001	2.502
ENTRYYR89	1.4927	0.11238	176.4146	<.0001	4.449
ENTRYYR90	1.81817	0.11234	261.9159	<.0001	6.161
ENTRYYR91	1.99679	0.11353	309.3413	<.0001	7.365
ENTRYYR92	2.17208	0.11315	368.4945	<.0001	8.777
ENTRYYR93	2.46896	0.11265	480.3557	<.0001	11.81
ENTRYYR94	2.84441	0.11201	644.8604	<.0001	17.191
ENTRYYR95	3.25545	0.1115	852.4257	<.0001	25.931
ENTRYYR96	3.69052	0.11048	1115.76	<.0001	40.066
ENTRYYR97	4.07706	0.10965	1382.535	<.0001	58.972
ENTRYYR98	4.27887	0.10988	1516.376	<.0001	72.159
ENTRYYR99	4.19828	0.11054	1442.353	<.0001	66.572

Variable	Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
ENTRYYR00	4.2522	0.11986	1258.611	<.0001	70.26
ENTRYYR01	4.03903	0.14376	789.3915	<.0001	56.771

Source: Author

All of the demographic characteristics also have significant effects on the retention behavior of Army officers at all usual levels. The hazard of separation for a female officer is 135.4 percent of that of a male officer, ceteris paribus. A married Army officer has a hazard of leaving the service that is 67 percent of that of a single Army officer, when controlling for other factors. Each one-year increase in the entry age increases the hazard of separation by 2.9 percent (100 * (1.029 – 1) = 2.9%).

All of the minority group officers have lower hazards of leaving when compared to white officers, and the coefficients are significant at all usual levels. Controlling for other variables, a black officer has a hazard of separation that is 75.9 percent of a white officer's; a Hispanic officer has a hazard of leaving that is 83.7 percent of a white officer's; and officers of other races have a hazard of leaving the Army that is 86.4 percent of that of a white officer.

All of the commissioning source variables are also significant at all usual levels. Furthermore, the hazard ratios of officers whose commissioning source is other than the Academy are lower than that of an Academy graduate. The hazard of separation for an officer whose commissioning source is ROTC scholarship is 93.1 percent of that of a USMA graduate, ceteris paribus. An ROTC non-scholarship graduate has a hazard of leaving that is 66.2 percent of that of an Academy graduate. Those with other sources of commission have a hazard of separation that is 73.9 percent of that of a USMA graduate. Officers who served as enlisted before being commissioned as an officer have a lower hazard of leaving the service than those who did not.

All of the officers serving in categories other than combat arms have higher hazards of separation and results are significant at all usual levels. An officer serving in combat support fields has a hazard of leaving that is 115.4 percent (15.4 percent higher) of that of officers serving in combat arm fields. Officers serving in combat service

support fields have a hazard of leaving that is 110.6 percent (10.6 percent higher), and officers serving in special branches have a hazard of leaving that is 127.3 percent (27.3 percent higher) of that of officers serving in combat arm fields.

The coefficients of the commissioning year variables are all significant with the exception of the FY 1986 variable. In general, the hazard of separation increases as commissioning year increases, again as in the results of the LIFEREG procedure, showing the general increasing separation trend among Army officers from year to year over the period.

The result of the ROTC scholar variable was not significant in the LIFEREG procedure, but it is significant in the PHREG procedure. All other results of the PHREG procedure are similar to the results of the LIFEREG procedure.

B. PROMOTION ANALYSIS

1. Analysis of Survival Patterns

Table 19 displays the life-table survival estimates for the promotion model. As seen in the table, during the first eight years, failed and censored columns are equal to zero. The reason is that officers were observed only after they had served eight years. The third column, which is called *number failed*, shows the number of officers who were promoted to major in that interval. For example, 5,837 officers were promoted to major between years 12 and 14. This group is the majority of the officers who were promoted to O-4. The number censored column, which is the fourth column, shows the number of officers who made it to that interval but were not promoted to O-4, and thus were censored. As explained earlier, censored officers either left the Army in that interval or continued to serve for the next interval. Effective sample size is calculated at the mid-point, as explained in the retention section of this chapter. Since there was no one promoted or censored until the eighth year, all officers used for the analysis were on active duty during that time with a rank lower than major.

The conditional probability of failure shows the probability that an officer is going to be promoted in that interval, given that he or she made it to the beginning of that interval. For example, the probability of an officer being promoted to O-4 between the

twelfth and thirteenth years is 0.9364, given that he or she is in the service at the beginning of that interval. The survival column shows that the event occurs later than or at the start time for each interval.[117] For example, the probability that an officer will not be promoted until the beginning of the tenth year is 0.9983. The failure column is calculated by subtracting the survival column from one. This column shows the opposite of the survival column; that is, it shows the probability of an event occurring by the beginning of that interval. For example, the probability that an officer is promoted to major by the beginning of the tenth year is 0.00168. The PDF and Hazard columns show the functions, as explained in the retention section of this chapter.

Table 19. Life - Table Survival Estimates (Promotion Model)

Lower Interval	Upper Interval	Number Failed	Number Censored	Effective Sample Size	Conditional Probability of Failure	Conditional Probability Standard Error	Survival	Failure
0	2	0	0	12092	0	0	1	0
2	4	0	0	12092	0	0	1	0
4	6	0	0	12092	0	0	1	0
6	8	0	0	12092	0	0	1	0
8	10	18	2784	10700	0.00168	0.000396	1	0
10	12	854	1858	8361	0.1021	0.00331	0.9983	0.00168
12	14	5837	689	6233.5	0.9364	0.00309	0.8963	0.1037
14	16	31	16	44	0.7045	0.0688	0.057	0.943
16	18	2	3	3.5	0.5714	0.2645	0.0168	0.9832

Source: Author

Table 19. Life - Table Survival Estimates (Promotion Model) (continued)

Lower Interval	Upper Interval	Survival Standard Error	PDF	PDF Standard Error	Hazard	Hazard Standard Error
0	2	0	0	.	0	.
2	4	0	0	.	0	.
4	6	0	0	.	0	.
6	8	0	0	.	0	.
8	10	0	0.000841	0.000198	0.000842	0.000198
10	12	0.000396	0.051	0.00165	0.053819	0.001839
12	14	0.00333	0.4197	0.00208	0.880392	0.005465
14	16	0.00278	0.0201	0.00219	0.54386	0.081971
16	18	0.00401	0.00481	0.0025	0.4	0.25923

Source: Author

[117] Allison, 45.

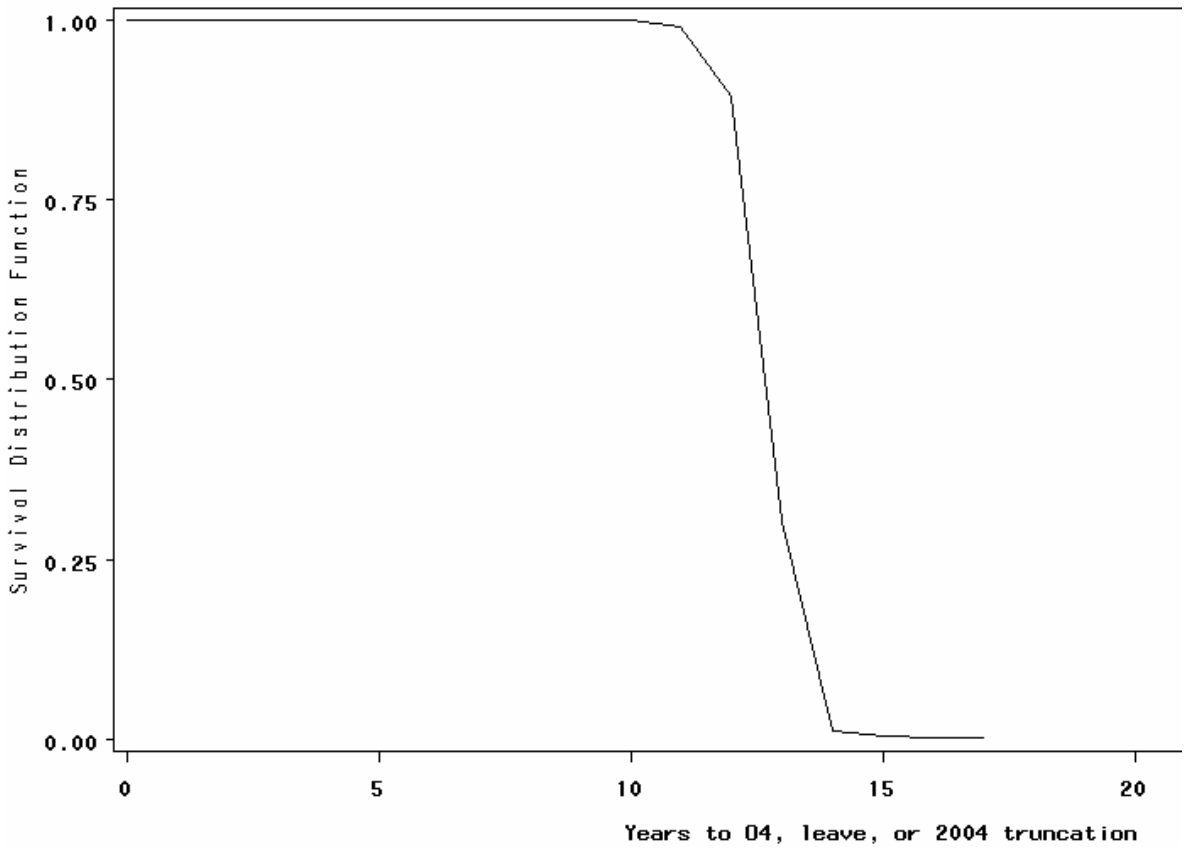
Table 20 shows the number of officers promoted and censored during the observation period, as calculated by the LIFETEST procedure in SAS software. As seen in the table, of 12,092 officers, 6,742 were promoted to O-4 by September 30, 2004.

Table 20. Censored (Not promoted) and Failed (Promoted) Values

Summary of the Number of Censored and Uncensored Values			
Total	**Failed**	**Censored**	**Percent Censored**
12092	6742	5350	44.24

Source: Author

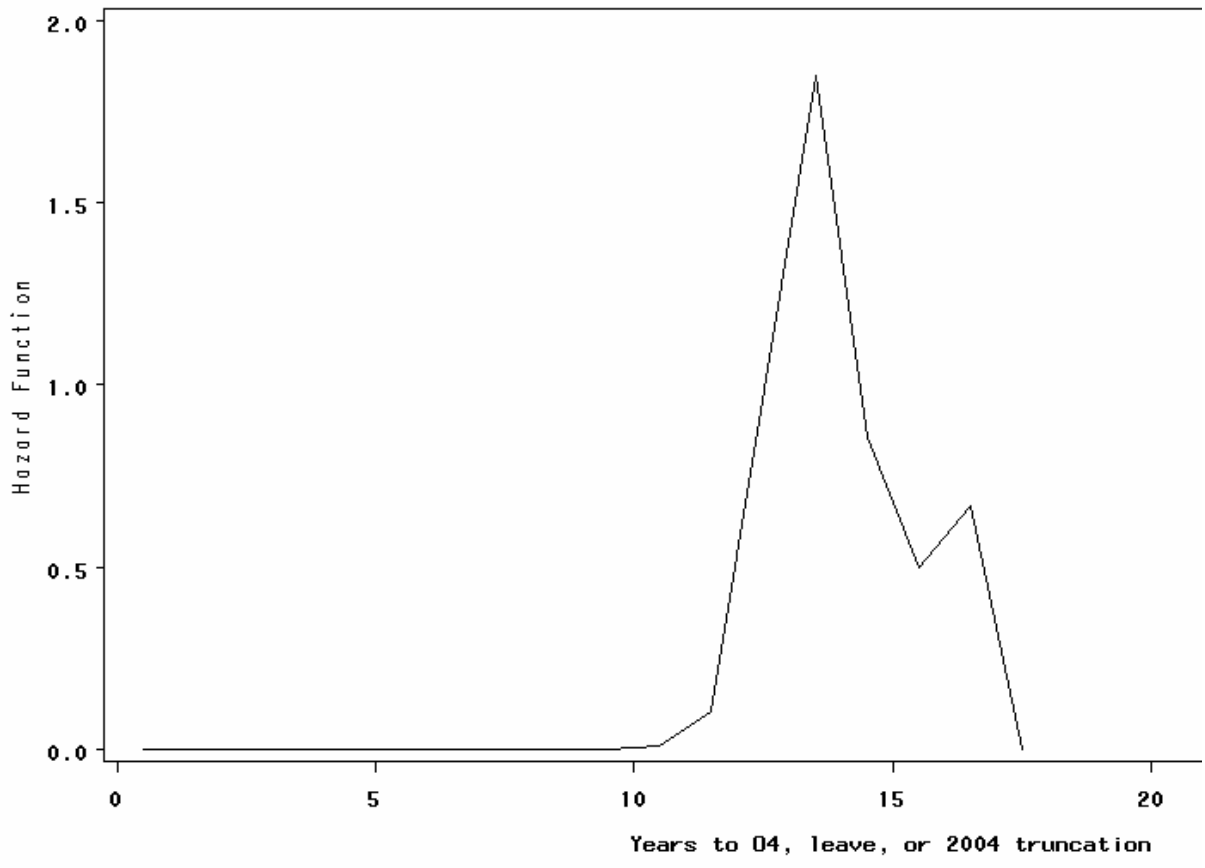
Figure 46 shows a plot of the survival (promotion) distribution function. As seen in the figure, the survival function is flat until the tenth year, indicating that almost no one is promoted during that time. Then, it begins going down slowly until the twelfth year, showing that a small number of officers are promoted during that time. Then it goes down sharply until the fourteenth year, illustrating that most of the officers are promoted during that time frame. It then slowly moves toward zero until the seventeenth year, which is the last year that officers are promoted to O-4. After that year, the value of the function is zero, showing that no one is promoted after that year.



Source: Author

Figure 46. Survival Distribution Function of Army Officers (Promotion Model)

Figure 47 shows the hazard (of promotion) function of officers. As seen in the figure, the hazard of being promoted to O-4 begins to increase slightly at about the tenth year. There is a sharp increase in the hazard of promotion after the twelfth year. Then it moves downward, beginning at the thirteenth year. There is small increase in the sixteenth year, indicating that the hazard of promotion increases a little bit up during that year. After that, it continues to decline, and at year 17 it becomes zero, again showing there is no promotion after that time, as with the survivor function.



Source: Author

Figure 47. Hazard Function of Army Officers (Promotion Model)

Table 21 shows the number of officers promoted to O-4 and the number of those censored, according to their education level, which is main focus of this study. Since there are only 20 doctorate degree holders in the sample, those officers are combined with the master's degree category. The failed column shows the number of officers promoted to O-4 by education level. Thus, 3,722 of the college graduates, 2,939 of the master's degree holders and 81 of the professional degree holders are promoted to major by the censoring point, which is September 30, 2004.

Table 21. Summary of the Number of Censored (Not Promoted) and Failed (Promoted) Values (Promotion Model)

EDUCATION LEVEL	Total	Failed	Censored	Percent Censored	Log-Rank	Wilcoxon
COLLEGE	8282	3722	4560	55.06	-78.088	-525431
MASTER'S DEGREE	3718	2939	779	20.95	58.523	317079
PROFESSIONAL DEGREE	92	81	11	11.96	19.565	208352

Source: Author

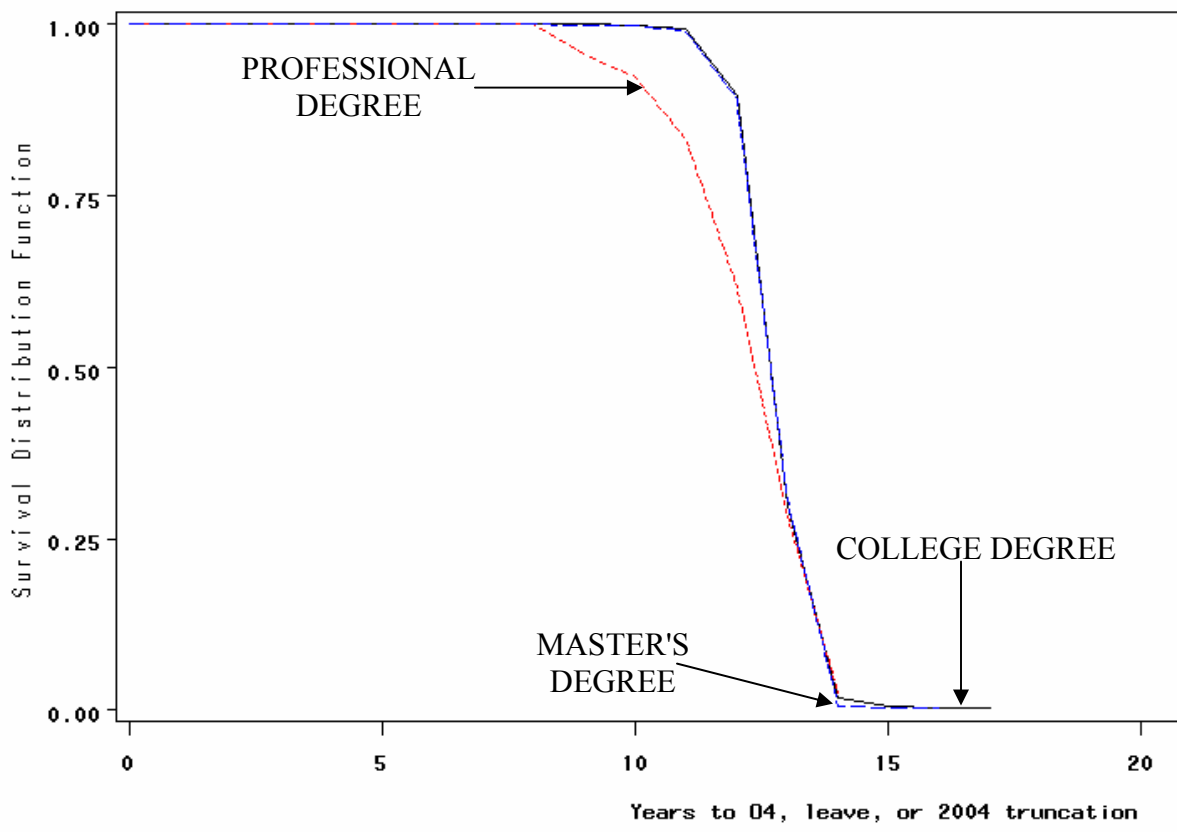
Table 22 displays the results of testing the null hypothesis that the survival functions (promotion) of officers with different education levels are the same. As seen in Table 22, we can reject the null hypothesis at all usual levels and conclude that survival functions of officers differ with their education levels. Thus, their promotion functions are different.

Table 22. Test Statistics for the Equality in Promotion Patterns of Officers with Different Education Levels

Test of Equality over Strata			
Test	**Chi-Square**	**DF**	**Pr > Chi Square**
Log-Rank	26.5995	2	<.0001
Wilcoxon	48.2064	2	<.0001
-2Log(LR)	372.457	2	<.0001

Source: Author

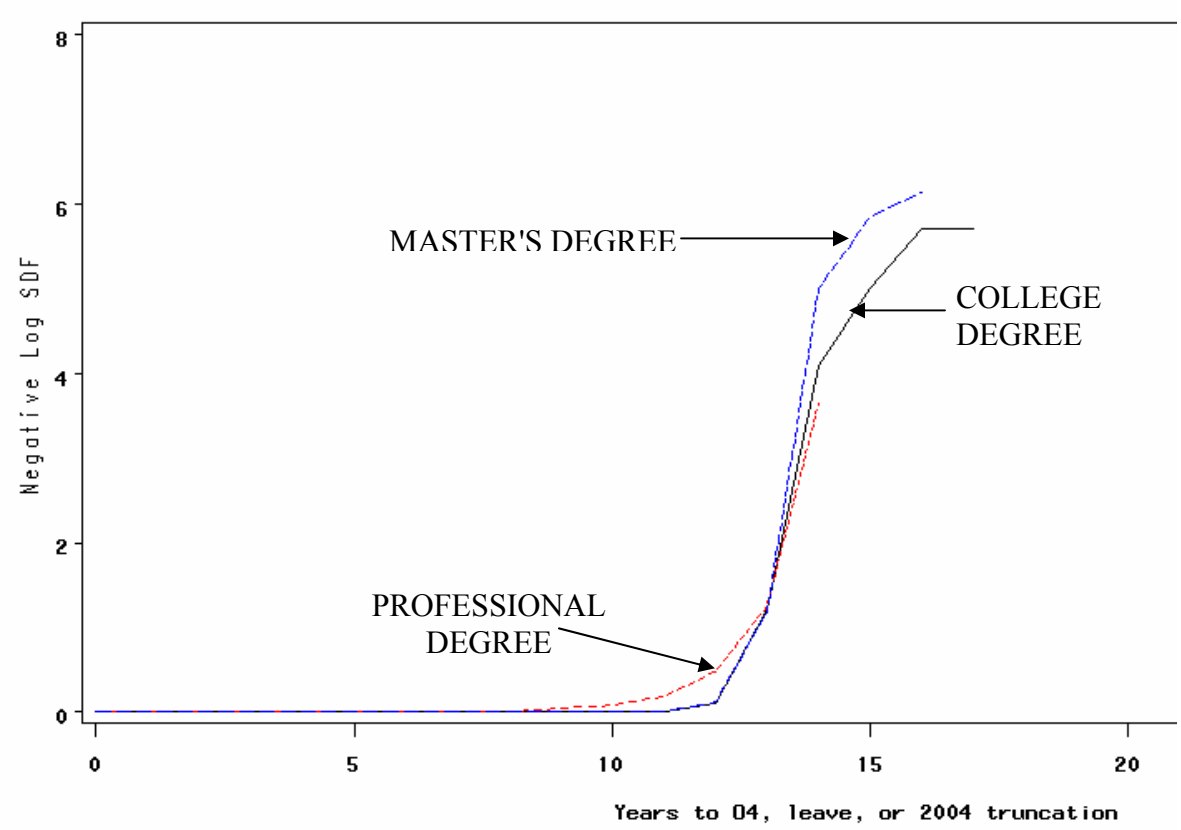
Figure 48 displays the survival (promotion) functions of officers with different educational levels. During the first eight years there is no difference between the survival functions of officers. This is due to the fact that this study examines only the promotion patterns of officers who served at least eight years. As seen in the figure, professional degree holders have the lowest survival curve, showing that those officers are promoted within shorter periods than the officers of other categories. Master's degree holders and college graduates seem to have similar survival functions, indicating that their promotion time to O-4 is almost equal. However, the bottom (right) of the figure illustrates that officers with master's degrees have a little bit shorter time to promotion than college graduates.



Source: Author

Figure 48. Survival Distribution Function of Army officers with Different Education Levels (Promotion Model)

Figure 49 displays the log-survival plot for officers with different education levels. The graphs for all groups increase at an increasing rate, especially after the twelfth year of service, showing that the hazard of promotion increases at an increasing rate until the fourteenth year. Then it increases with a decreasing rate. This figure illustrates more clearly that the promotion patterns of college graduates and master's degree holders are not the same. Furthermore the sharpest increase is observed for officers who have master's degrees.



Source: Author

Figure 49. Log-Survival Plot for Army Officers with Different Education Levels (Promotion Model)

2. Results of Estimating Parametric Regression Models

Table 23 displays the results of the LIFEREG procedure for all five different distributions for the promotion model. As was the case in the retention model, the magnitudes and significance levels of explanatory variables in the promotion model also differ from distribution to distribution. The parameter estimates cannot be interpreted directly and conversion is required. As in the retention model, the signs of the coefficients show the direction of the effect. If the sign is negative, then this variable decreases the time to be promoted to O-4. If it is positive, then it increases the time to promotion to major.

Table 23. Results of PROC LIFEREG Procedure (Promotion Model)

	LNORMAL		WEIBULL		EXPONENT		GAMMA		LLOGISTIC	
Variable	Estimate	ChiSq	Estimate	ChiSq	Estimate	ChiSq	Estimate	ChiSq	Estimate	ChiSq
Intercept	2.60198	<.0001	2.63256	<.0001	3.25129	<.0001	2.6002	<.0001	2.58529	<.0001
GRADUATEDEGREE	-0.002	0.0393	-0.0056	<.0001	-0.3723	<.0001	-0.0021	0.0272	-0.0011	0.1305
PROFESSIONALDEGREE	-0.0299	<.0001	0.00246	0.6235	-0.4883	<.0001	-0.0247	<.0001	-0.0112	0.0178
FEMALE	-0.0049	0.0021	-0.0164	<.0001	-0.0038	0.9255	-0.0052	0.0009	-0.0032	0.0159
MARRIED	-0.0009	0.4936	-0.0154	<.0001	-0.2216	<.0001	-0.0014	0.2986	-0.0009	0.4221
ENTRYAGE	-0.0015	<.0001	-0.0015	<.0001	0.00227	0.7044	-0.0014	<.0001	-0.0009	<.0001
BLACK	0.00475	0.002	0.00877	<.0001	0.09477	0.0224	0.00494	0.0013	0.0033	0.007
HISPANIC	0.001	0.783	0.00224	0.6064	0.15589	0.1156	0.00136	0.7076	0.00164	0.5722
OTHERRACE	-0.0064	0.0151	-0.0058	0.0603	0.02028	0.7723	-0.0058	0.0283	-0.0016	0.4577
ROTCSCHOLAR	0.00076	0.6365	-0.0075	<.0001	-0.001	0.9815	0.00074	0.6444	0.00119	0.313
ROTCNONSCHOLAR	0.00035	0.7896	-0.0013	0.428	-0.0167	0.6283	0.00054	0.6833	0.00118	0.2376
OTHERSOURCE	-0.0104	<.0001	-0.0005	0.8193	-0.052	0.2875	-0.0101	<.0001	-0.0075	<.0001
PREENLIST	-0.0068	<.0001	-0.0008	0.6168	-0.0205	0.5402	-0.0065	<.0001	-0.0045	<.0001
COMBATSUPPORT	0.00381	0.0255	0.00638	0.0013	0.04483	0.3173	0.00368	0.0301	0.00172	0.1693
COMBATSERVICESUPPORT	-0.0044	0.0039	0.00806	<.0001	0.05974	0.1424	-0.0041	0.0073	-0.0037	0.0014
SPECIALBRANCHES	-0.045	<.0001	-0.0038	0.0866	-0.0799	0.0919	-0.0427	<.0001	-0.0404	<.0001
ENTRYYR82	-0.0206	<.0001	-0.0274	<.0001	0.04255	0.4942	-0.02	<.0001	-0.0122	<.0001
ENTRYYR83	-0.068	<.0001	0.02774	<.0001	0.45955	<.0001	-0.0678	<.0001	-0.0769	<.0001
ENTRYYR84	-0.037	<.0001	-0.0019	0.5195	0.36821	<.0001	-0.0347	<.0001	-0.0187	<.0001
ENTRYYR85	-0.0514	<.0001	-0.0448	<.0001	-0.0082	0.8885	-0.0506	<.0001	-0.0597	<.0001
ENTRYYR86	-0.0547	<.0001	-0.0516	<.0001	-0.0473	0.3436	-0.0539	<.0001	-0.0623	<.0001
ENTRYYR87	-0.0678	<.0001	-0.0812	<.0001	-0.149	0.0025	-0.0679	<.0001	-0.0722	<.0001
ENTRYYR88	-0.0789	<.0001	-0.0943	<.0001	-0.225	<.0001	-0.079	<.0001	-0.0774	<.0001
ENTRYYR89	-0.1527	<.0001	-0.1694	<.0001	0.24045	0.0006	-0.1531	<.0001	-0.1558	<.0001
ENTRYYR90	-0.2046	<.0001	-0.1967	<.0001	2.07581	<.0001	-0.205	<.0001	-0.2167	<.0001
ENTRYYR91	-0.2135	<.0001	-0.108	<.0001	3.32502	<.0001	-0.1976	<.0001	-0.1808	0.1355
ENTRYYR92	-0.1478	<.0001	-0.0941	0.0024	3.51501	<.0001	-0.1381	<.0001	-0.0832	0.0002
ENTRYYR93	-0.113	0.9273	0.17079	0.9805	18.2217	0.9989	-0.0943	0.9675	0.00377	0.9999
ENTRYYR94	-0.2188	0.8627	0.05721	0.9935	18.1177	0.9989	-0.1997	0.9333	-0.1026	0.9967
ENTRYYR95	-0.3311	0.7772	-0.0709	0.992	18.0366	0.9989	-0.3098	0.8986	-0.2173	0.9923

Source: Author

The log likelihoods for the five different models are shown in Table 24. If chi-square statistics are calculated using these log likelihoods, as explained in the retention analysis section of this chapter, then the results seen in Table 25 are obtained. The exponential and Weibull models are rejected, and the Log-logistic model is rejected as

well. Both the log-normal and gamma models appear to fit the data very well. The results on Table 23 illustrate that the log-normal and gamma distributions produce approximately the same results.

Table 24. Log Likelihoods of All Distributions (Promotion Model)

Name of Distribution	Log-likelihood
LNORMAL	11699.35261
WEIBULL	10396.03146
EXPONENT	-9478.388128
GAMMA	11707.76049
LLOGISTC	12464.55617

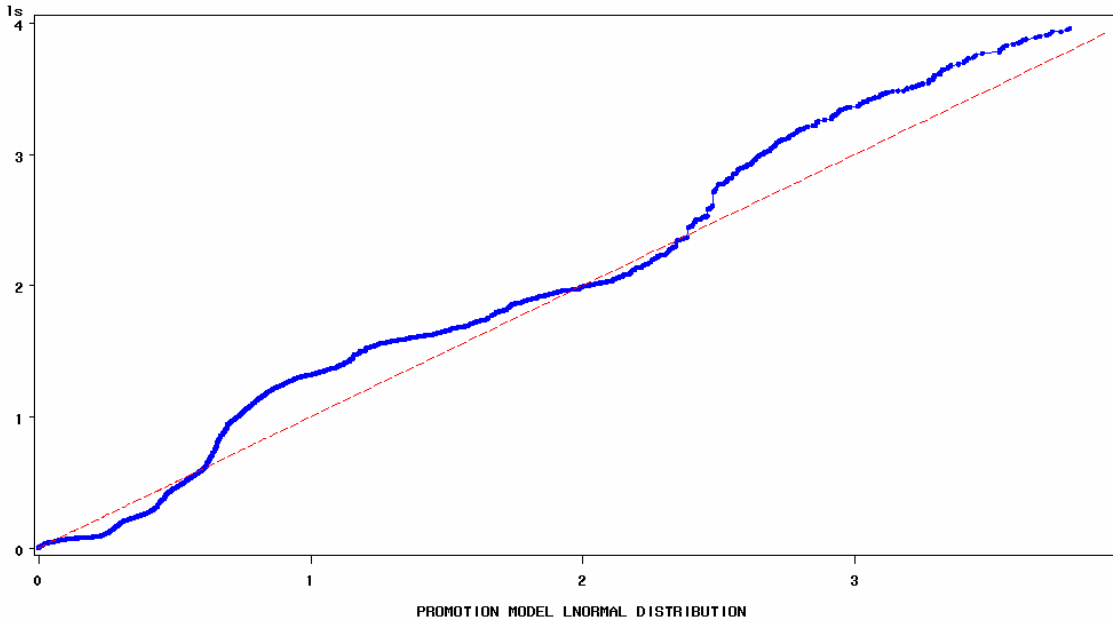
Source: Author

Table 25. Chi-Square Statistics within Nested Models (Promotion Model)

Comparison	Chi-Square
Exponential vs. Weibull	39748.84
Exponential vs. Gamma	42372.30
Weibull vs. Gamma	2623.46
Log-Normal vs. Gamma	16.82
Log-Logistic vs. Gamma	1513.59

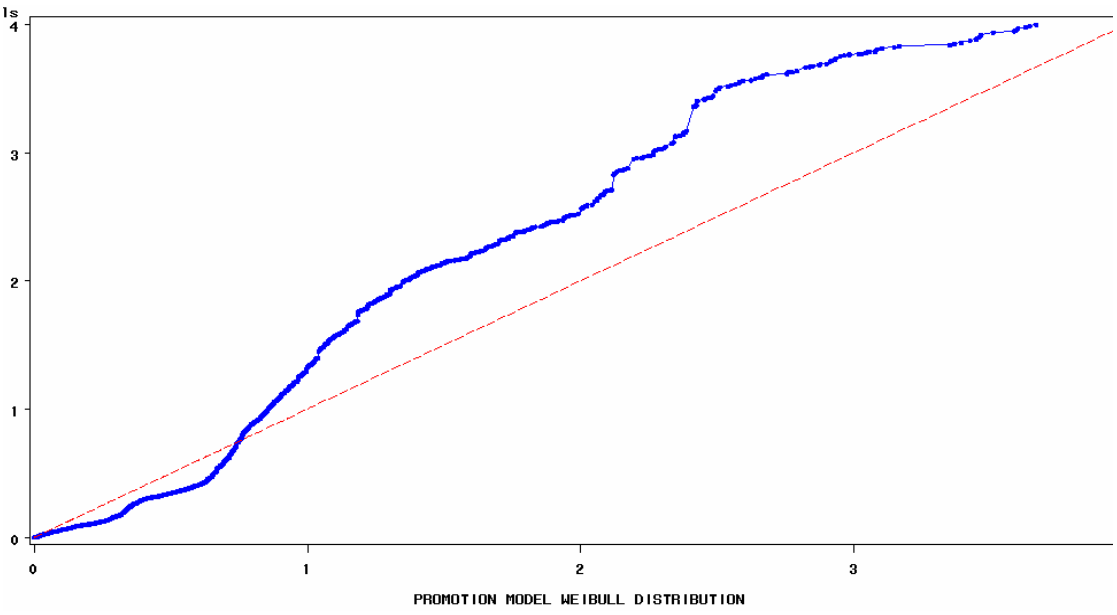
Source: Author

In order to be sure of the model fit, the graphical method is also used for the selection of the appropriate distribution. Figures 50 through 54 plot the residuals for all distributions. As seen in the figures, the log-normal and gamma models fit the data better than the other distributions. Based on the results of both methods, the gamma distribution is used for analysis of promotion.



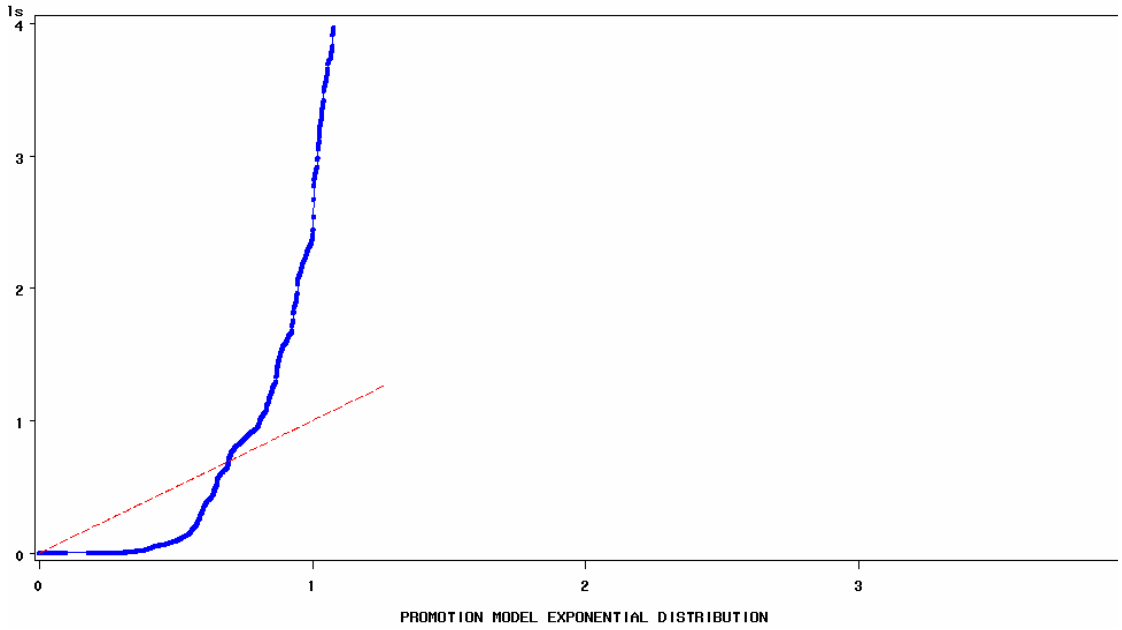
Source: Author

Figure 50. Residual Plot – Promotion Model (Log-Normal Distribution)



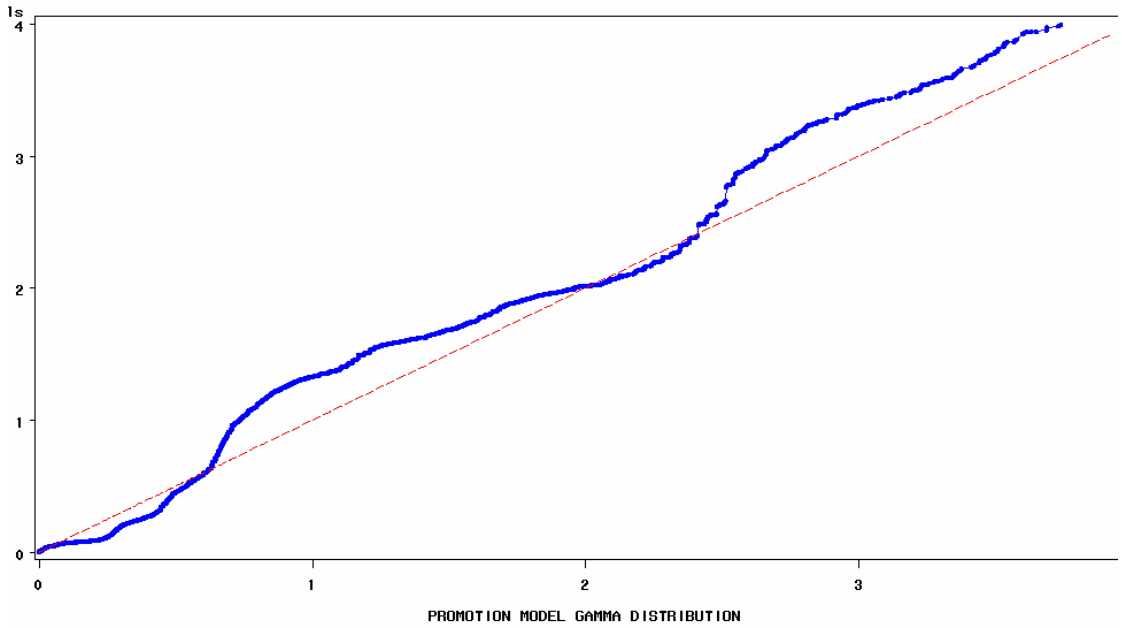
Source: Author

Figure 51. Residual Plot - Promotion Model (Weibull Distribution)



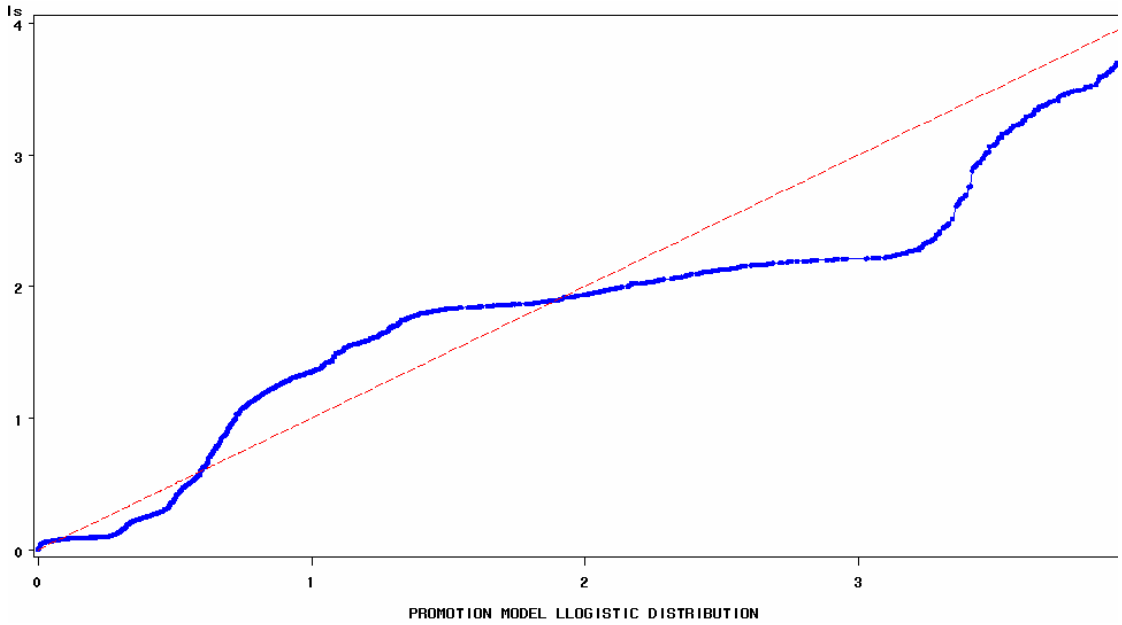
Source: Author

Figure 52. Residual Plot - Promotion Model (Exponential Distribution)



Source: Author

Figure 53. Residual Plot - Promotion Model (Gamma Distribution)



Source: Author

Figure 54. Residual Plot - Retention Model (Log – logistic Distribution)

Table 26 displays the results of the LIFEREG procedure for the gamma distribution. The *Effect* column in the table is produced by using the *Estimate* column in the same table, and it shows the effect of variables in percentage points.

The results show that both master's and professional level education have negative effects on the time to promotion for Army officers. The effect of a master's degree is significant at the 0.05 level and that of professional degree is significant at all usual levels, as seen in the table (p-values). The expected time for promotion to O-4 for an officer with a master's degree is 0.21 percent less than that for an officer who has only a baccalaureate degree, accounting for other covariates, and the expected time for promotion to major for an officer with a professional degree is 2.43 percent less.

For the demographic variables, being female, belonging to the other race category (compared to white), and each additional year of age at entry decrease the time to promotion to O-4, whereas being black increases it, compared to a white officer. The coefficients of the female, entry age and black variables are significant at all usual levels. However, the coefficient of the other race variable is significant at 0.05 level. The expected time for promotion to major for a female officer is 0.52 percent less than that of

a male officer, ceteris paribus. Each additional year in age at entry decreases the promotion time to O-4 by 0.14 percent, other things being equal. The expected promotion time to major for black officers is 0.50 percent higher than that of white officers, and the expected promotion time to major for officers of other races is 0.58 percent shorter than that of white officers, controlling for other factors. Being Hispanic and being married have no significant effect on promotion time of officers.

Table 26. Results of Gamma Distribution (Promotion Model)

Variable	Estimate	Effect (%)	Chi-Square	Pr > ChiSq
Intercept	2.6002		233667.631	<.0001
GRADUATEDEGREE	-0.0021245	-0.21222	4.8786	0.0272
PROFESSIONALDEGREE	-0.02465	-2.43487	29.1801	<.0001
FEMALE	-0.0052296	-0.52159	10.937	0.0009
MARRIED	-0.0014434	--	1.0806	0.2986
ENTRYAGE	-0.0014293	-0.14283	40.0565	<.0001
BLACK	0.0049434	0.49556	10.3298	0.0013
HISPANIC	0.0013642	--	0.1407	0.7076
OTHERRACE	-0.0057829	-0.57662	4.8071	0.0283
ROTCSCHOLAR	0.0007377	--	0.213	0.6444
ROTCNONSCHOLAR	0.0005409	--	0.1664	0.6833
OTHERSOURCE	-0.01013	-1.00789	29.5805	<.0001
PREENLIST	-0.0064971	-0.64760	26.1305	<.0001
COMBATSUPPORT	0.003684	0.36908	4.7016	0.0301
COMBATSERVICESUPPORT	-0.0041051	-0.40967	7.2003	0.0073
SPECIALBRANCHES	-0.04272	-4.18204	495.4733	<.0001

Source: Author

Commissioning source variables have no statistically significant effect on promotion time to major for officers, with the exception of OTHERSOURCE. The expected promotion time to O-4 for officers commissioned through other sources is 1.01 percent less than for USMA graduates, ceteris paribus. The coefficient of OTHERSOURCE is significant at all usual levels. Officers who have served as enlisted

personnel before being commissioned have 0.65 percent shorter promotion time to major than those who have not, and this result is significant at 0.01 level.

While serving in the combat support category increases promotion time to O-4, serving in the combat service support or special branch categories decreases promotion time to O-4, when compared to officers serving in the combat arms category. The expected promotion time to O-4 for an officer serving in the combat support field is 0.37 percent more than that of an officer serving in the combat arms fields. On the other hand, the expected promotion time to major for an officer serving in the combat service support category is 0.41 percent less. For an officer serving in special branches, it is 4.18 percent less than that of an officer serving in the combat arms field, controlling for other factors. The coefficient of the COMBATSUPPORT variable is significant at the 0.05 level. The coefficients of COMBATSERVICESUPPORT and SPECIALBRANCHES are significant at all usual levels.

3. Results of Estimating Cox Regression Models

The test results for the global null hypothesis that all of the coefficients are equal to zero (the explanatory variables have no effect on the promotion of officers) are given in Table 27. All of the test results have p-values of less than 0.0001, showing that at least one of the coefficients is not equal to zero.

Table 27. Global Test Statistics for the Promotion Model for the Null Hypothesis that All Coefficients are Equal to Zero

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	3014.196	29	<.0001
Score	5105.179	29	<.0001
Wald	3387.34	29	<.0001

Source: Author

Table 28 displays the results of the PHREG procedure. Having a master's degree has a positive effect on the promotion of officers. An officer with a master's degree has a hazard of promotion that is 115.3 percent of that of an officer with a college degree (base case) (15.3 % more), controlling for the other variables. This shows that attending a

graduate school and obtaining a master's degree increases the probability of promotion to major by 15.3 percent when compared to a college graduate. The associated p-value is less than 0.0001, indicating that this result is significant at all usual levels. On the other hand, having a professional degree has no effect on the hazard of promotion of officers.

Being female and married both have a positive effect on the promotion of Army officers, whereas being black has a negative effect (compared to being white), and those results are significant at all usual levels. The hazard of promotion to O-4 for a female officer is 116.5 percent of that of a male officer, ceteris paribus. A married Army officer has a hazard of promotion to major that is 115.6 percent of that of a single Army officer, when controlling for the other factors. A black officer has a hazard of promotion to O-4 that is 80.2 percent of that of a white officer, other things being equal. Age at entry, being Hispanic and being of another race have no significant effect on the hazard of promotion for officers.

Commissioning sources have no significant effect on the hazard of promotion for Army officers, with the exception of other source. Officers who have been commissioned through other sources have a hazard of promotion to major that is 110.5 percent of that of USMA graduates, ceteris paribus, and this effect is significant at the 0.05 level. Officers who have been enlisted before being commissioned have a higher hazard of promotion to major than those who had not. These officers have a hazard of promotion to major that is 110.2 percent of that of officers who were not enlisted members before being commissioned, ceteris paribus. The coefficient is significant at all usual levels.

Table 28. Results of the PHREG Procedure for the Promotion Model

Variable	Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
GRADUATEDEGREE	0.14261	0.02539	31.5354	<.0001	1.153
PROFESSIONALDEGREE	0.04259	0.11406	0.1394	0.7088	1.044
FEMALE	0.15264	0.04057	14.1528	0.0002	1.165
MARRIED	0.14486	0.03728	15.0998	0.0001	1.156
ENTRYAGE	0.00904	0.00572	2.5011	0.1138	1.009
BLACK	-0.22028	0.04176	27.8233	<.0001	0.802
HISPANIC	-0.14601	0.09926	2.1636	0.1413	0.864
OTHERRACE	0.00642	0.07012	0.0084	0.927	1.006
ROTCSCHOLAR	-0.04569	0.04204	1.1812	0.2771	0.955
ROTCNONSCHOLAR	-0.05304	0.03567	2.2109	0.137	0.948
OTHERSOURCE	0.09943	0.04909	4.1016	0.0428	1.105
PREENLIST	0.0975	0.03439	8.038	0.0046	1.102
COMBATSUPPORT	-0.06626	0.04505	2.1627	0.1414	0.936
COMBATSERVICESUPPORT	-0.02582	0.04106	0.3955	0.5294	0.975
SPECIALBRANCHES	0.49981	0.04681	113.982	<.0001	1.648
ENTRYYR82	0.31169	0.06233	25.0097	<.0001	1.366
ENTRYYR83	1.28722	0.0923	194.483	<.0001	3.623
ENTRYYR84	0.46009	0.06619	48.3132	<.0001	1.584
ENTRYYR85	0.82923	0.05888	198.325	<.0001	2.292
ENTRYYR86	0.85914	0.05053	289.032	<.0001	2.361
ENTRYYR87	1.19942	0.05159	540.439	<.0001	3.318
ENTRYYR88	1.61881	0.05067	1020.65	<.0001	5.047
ENTRYYR89	3.93556	0.08403	2193.63	<.0001	51.191
ENTRYYR90	4.91107	0.24938	387.812	<.0001	135.784
ENTRYYR91	1.35657	0.50364	7.2552	0.0071	3.883
ENTRYYR92	1.19826	0.70989	2.8492	0.0914	3.314
ENTRYYR93	-3.79426	210.104	0.0003	0.9856	0.022
ENTRYYR94	-3.95395	583.775	0	0.9946	0.019
ENTRYYR95	-4.02544	1227	0	0.9974	0.018

Source: Author

While serving in the special branches field has a positive effect on the hazard of promotion for Army officers, serving in combat support or combat service support has no statistically significant effect on the hazard of promotion to O-4, compared with serving in the combat arms branch. Officers in the special branches category have a hazard of

promoting to major that is 164.8 percent of that of officers in combat arms, controlling for other factors. The coefficient of the SPECIALBRANCHES variable is significant at all usual levels.

The coefficients of the commissioning year variables are all significant with the exception of the FY 1993, FY 1994 and FY 1995 variables. In general, the hazard of promotion increases with commissioning year.

C. COMPARISON OF HYPOTHESIZED AND OBSERVED EFFECTS

This study focuses mainly on the effects of advanced education on the retention and promotion of Army officers; however, it also analyzes some other factors that may affect retention and promotion.

Survival analysis is used as an empirical approach in order to evaluate the effects of explanatory variables on retention and promotion. Survival analysis gives not only the partial effects of variables on the probability of separation or promotion, but also the effects on the time that it takes until separation or promotion occurs. The LIFEREG procedure gives the results for the survival function, which shows the effect of a variable on the time until the event occurs. The PHREG procedure gives the results for the hazard function, which produces partial effects on the probability of occurrence of the events.

This section compares the hypothesized and actual effects of variables for each independent variable. The tables include the effects estimated with the LIFEREG and PHREG procedures in SAS software.

The sign in the LIFEREG column shows the direction of the effect on time to the event. Thus, for retention analysis, a positive sign indicates that the variable increases the service time (survival time). However, for promotion analysis, it shows that the variable increases the time to promotion to major. The sign in the PHREG column shows the effect of a variable on the occurrence of separation or promotion; that is, a positive sign indicates that the hazard of separation or promotion is greater than for the base case (for a binary variable), and a negative sign indicates that the variable decreases the hazard of separation or promotion when compared to the base case. If the variable is continuous,

then the sign of the coefficient in the PHREG results shows the direction of the effect of each additional unit increase in the variable on the hazard of separation or promotion. The signs of the continuous variables in the LIFEREG procedure results indicate the direction of the effect of each one unit increase in that variable on the service or promotion time of an officer in percentage points.

1. Education Variables

One hypothesis related to the education variables was that the survival functions of officers would differ with the education level for both retention and promotion. Results of the LIFETEST procedure show that survival functions of officers differ with their education levels for both the retention and promotion models, and these findings are significant at all usual levels using the log-rank, Wilcoxon, and likelihood-ratio tests.

Another hypothesis related to education levels of officers was that any type of advanced education would have a positive effect on both retention and promotion. The results summarized in Table 29 show that all types of advanced education have a positive effect on survival times and a negative effect on the hazard of separation of officers for the retention model. Thus, advanced education increases survival time of officers and decreases the hazard of separation when compared to baccalaureate degree only..

Table 29. Hypothesized and Observed Effects of Education Variables

Variable	Retention			Promotion		
		Findings			Findings	
	Hypothesis	LIFEREG	PHREG	Hypothesis	LIFEREG	PHREG
GRADUATEDEGREE	+	+***	-***	+	-**	+***
DOCTORATEDEGREE	+	+***	-***	+	N/A	N/A
PROFESSIONAL DEGREE	+	+***	-***	+	-***	+
COLLEGEDEGREE	BASE CASE					

* Significant at 0.10 level
** Significant at 0.05 level
*** Significant at 0.01 level

Source: Author

For the promotion model, the doctorate degree holders are combined with the master's degree holders for survival analysis. As seen in Table 29, a graduate degree decreases the time for promotion to major and increases the hazard of promotion to O-4. However, although a professional degree decreases the time for promotion to major, it has no significant effect on the hazard of being promoted to major. For both the retention and promotion models, the hypothesized and observed effects of the education variables are the same, with the exception of the effect of a professional degree on the hazard of promotion, which has no significant effect.

2. Demographic Variables

Table 30 summarizes the hypothesized and observed effects of demographic variables on retention and promotion. As hypothesized, being female decreases service time and increases the hazard of separation. However, as opposed to the hypothesis, being female decreases the time for promotion to O-4 and increases the hazard of being promoted to major. There are some studies in the literature that found similar results. Branigan (2001), for example, found that female officers were more likely to be selected for promotion to O-5.[118] Buterbaugh (1995), Wielsma (1996) and Kabalar (2003) all found that gender had no significant effect on promotion.

Being married has the expected effect, which is that it increases service time and the hazard of promotion to O-4, and decreases the hazard of leaving the service, when compared to single officers. However, being married has no significant effect on time for promotion to major.

Age at entry has unexpected results for the retention model and the expected results for the promotion model. Each additional year in age at entry decreases service time and time to promotion to O-4, and increases the hazards of separation and promotion to major. This result may be attributable to the fact that officers who are older at entry may have more difficulty in adapting to military life and prefer leaving the service earlier. However, those older entrants who decided to stay in the Army may have found

[118] Gregory A.Branigan, "The Effect of Graduate Education on the Retention and Promotion of Marine Corps Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2001), 1.

the military to be the job best matching their characteristics and expectations after spending several years in the civilian labor market. They may therefore be more productive and promotable. In addition, prior enlisted officers are older at entry into commissioned service than those with no prior service, and they need to serve a shorter time as officers to be eligible for retirement.

Table 30. Hypothesized and Observed Effects of Demographic Variables

Variable	Retention			Promotion		
		Findings			Findings	
	Hypothesis	LIFEREG	PHREG	Hypothesis	LIFEREG	PHREG
FEMALE	-	-***	+***	-	-***	+***
MARRIED	+	+***	-***	+	-	+***
ENTRYAGE	+	-***	+***	+	-***	+
BLACK	+	+***	-***	-	+***	-***
HISPANIC	+	+***	-***	-	+	-
OTHER RACE	+	+***	-***	-	-**	+
WHITE	BASE CASE					

* Significant at 0.10 level
** Significant at 0.05 level
*** Significant at 0.01 level

Source: Author

The race/ethnicity variables have the expected results, with the exception of the effect of OTHERRACE on promotion time. As hypothesized, being a member of a minority group increases service time and decreases the hazard of separation, when compared to the base case, which is a white officer. Being black significantly increases the time for promotion to O-4 and decreases the hazard of being promoted to major, compared to a white officer. Being a member of the other race group decreases time for promotion to O-4; however, it has no significant effect on the hazard of being promoted to O-4. Being Hispanic has no effect on promotion. This result is similar to some of the previous studies. Buterbaugh (1995), Wielsma (1996), Kizilkaya (2004) and Perry (2006) did not find any significant relationship between being Hispanic and promotion.

3. Commissioning Source Variables

The commissioning source variables have unexpected results. All commissioning source variables, with the exception of ROTCSCHOLAR, increase service time compared to an Academy graduate, which is the opposite of the hypothesized effect. Furthermore, all commissioning source variables decrease the hazard of separation when compared to Academy graduates. Having been commissioned through a source other than the three major sources decreases the time for promotion to O-4 and increases the hazard of being promoted to major. Having been commissioned through ROTC, with or without a scholarship, has no effect on promotion.

Fagan (2001) found that OCS graduates (represented in the OTHERSOURCE group in this study) are more productive and successful on the job.[119] Kizilkaya (2004) found that Academy graduates are more likely to leave the Army[120] than officers from other commissioning sources, which is similar to the findings of this study. Furthermore, he found that Academy graduates were less likely to be promoted to major than those from other sources, and that OCS graduates had the highest promotion probabilities[121], which is the same result as in this study. In addition, Mitchell et al. (2000) found in an analysis of survey data that officers commissioned through the USMA are less likely to plan to stay than those commissioned through any other source.[122] The researchers stated that the reason for low retention might be the fact that there were differences between what the officers were taught in the Academy and what they actually experienced in the field. Another reason suggested was that Academy graduates may have more opportunities in the civilian sector than other officers, since they receive a highly selective military academy education.

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[119] Billy K.Fagan, "Analysis Of Determinants Of Training Performance, Retention, And Promotion To Lieutenant Commander Of Naval Flight Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2002).

[120] Zafer Kizilkaya, "An Analysis of the Effect of Commissioning Sources on Retention and Promotion of U.S. Army Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2004).

[121] Ibid.

[122] D. Mitchell et al., "Predictors of US Army Captain Retention Decisions," quoted in Zafer Kizilkaya, "An Analysis of the Effect of Commissioning Sources on Retention and Promotion of U.S. Army Officers," (Master's Thesis, Naval Postgraduate School, Monterey, California, 2004).

Table 31. Hypothesized and Observed Effects of Commissioning Source Variables

Variable	Retention			Promotion		
		Findings			Findings	
	Hypothesis	LIFEREG	PHREG	Hypothesis	LIFEREG	PHREG
ROTCSCHOLAR	-	-	-***	-	+	-
ROTCNONSCHOLAR	-	+***	-***	-	+	-
OTHERSOURCE	-	+***	-***	-	-***	+**
ACADEMY	BASE CASE					

* Significant at 0.10 level
** Significant at 0.05 level
*** Significant at 0.01 level

Source: Author

Finally, Doganca (2006) found that ROTC non-scholarship and OCS graduates (represented in the OTHERSOURCE group in this study) have lower hazards of leaving than USMA graduates.[123] According to Doganca, most OCS officers have served as enlisted and may have more realistic expectations about the military since they are more familiar with the Army. This may lead to longer service for the OCS graduates compared to USMA graduates.

4. Prior Enlistment Status Variable

It has been hypothesized that serving as an enlisted service member before being commissioned as an officer would have a positive effect on both retention and promotion of officers. That is, prior enlisted officers were expected to stay in the Army for longer periods and be more likely to be promoted to O-4. The findings of this study support this hypothesis. Officers who have been enlisted before being commissioned have longer service times and shorter promotion times. In addition, being prior enlisted increases the hazard of being promoted and decreases the hazard of leaving the service.

5. Military Occupational Specialty Variables

Military occupational specialties have the expected results for the retention model, and all LIFEREG and PHREG results for the combat service support field and

[123] Erkan Doganca, "Officer Career Paths and the Effects of Commissioning Sources on the Survival Patterns of Army Officers,", (Master's Thesis, Naval Postgraduate School, Monterey, California, 2006).

special branches are significant at the usual levels. The combat support field variable is significant at the 0.10 level for the LIFEREG procedure for the retention model. As hypothesized, serving in one of the fields other than combat arms decreases service time in the Army and increases the hazard of leaving the service, when compared to a combat arms officer.

For the promotion model, the results differ according to the MOS category. Combat support officers have longer promotion times to O-4, whereas combat service support and special branch officers have shorter times, when compared to officers serving in the combat arms field. Serving in the special branches increases the hazard of being promoted to major. However, serving in the combat support or combat service support categories has no significant effect on the hazard of being promoted. The Army's needs are an important factor in promotion, as explained earlier. The promotion probability among different military occupational specialties may differ because the Army may need a greater portion of officers serving in a given category to be promoted to O-4. For example, the Army may need a higher proportion of majors in the special branches (doctors, lawyers etc.) category than in other categories, which in turn causes the officers serving in that category to have higher rates of promotion to major and shorter times to be promoted to O-4. This may be one reason that special branch officers are more likely to be promoted to major in shorter periods than combat arms officers.

Table 32. Hypothesized and Observed Effects of Occupational Specialty Variables

Variable	Retention			Promotion		
		Findings			Findings	
	Hypothesis	LIFEREG	PHREG	Hypothesis	LIFEREG	PHREG
COMBATSUPPORT	-	-*	+***	-	+**	-
COMBATSERVICESUPPORT	-	-***	+***	-	-***	-
SPECIALBRANCHES	-	-***	+***	-	-***	+***
COMBATARMS	BASE CASE					

* Significant at 0.10 level
** Significant at 0.05 level
*** Significant at 0.01 level

Source: Author

D. CHAPTER SUMMARY

This chapter uses survival analysis techniques to estimate the effect of education level and some other characteristics of Army officers on retention and promotion. In general, results show that advanced education has a positive effect on both retention and promotion. Advanced education increases the hazard of being promoted to major and service time as an officer, and it decreases the hazard of separation and promotion time to O-4. One exception is that having a professional degree has no significant effect on the hazard of being promoted to major.

Being married, being a minority, being commissioned through ROTC non-scholarship or other source, and being prior enlisted increase service time in the Army; whereas being female and serving in any military occupational field other than combat arms decreases service time. Furthermore, while female officers, prior enlisted officers, officers of other race, officers commissioned through other sources and officers serving in combat service support or special branch fields have shorter promotion times to major, black officers and officers serving in combat support fields have longer promotion times to O-4.

Being female or serving in any occupational category other than combat arms increases the hazard of leaving. On the other hand, being married, being a minority, having served as enlisted or being commissioned through any source other than USMA decreases the hazard of separation. Female officers, officers commissioned through other sources, prior enlisted officers, and officers serving in the special branches are more likely to be promoted. Being black decreases the hazard of being promoted to major.

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VII. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The main focus of this study is the effect of advanced education on the retention and promotion of Army officers. Four variables for highest level of education are used for the retention model - college degree (baccalaureate), master's degree, doctorate, and professional degree. For the promotion model, three educational levels are used - college degree, master's degree or doctorate and professional degree. Since the number of doctorate holders is too few in the promotion sample, they are combined with master's degree holders. In general, results show that having an advanced education degree increases the service time of Army officers and the hazard of being promoted to major. Furthermore, results show that advanced education decreases the hazard of leaving the Army and the time to promotion to major.

Survival analysis is used as an empirical approach in order to estimate the models. Survival analysis not only provides the partial effects of variables on the probability of separation or promotion but also the effects on the time that it takes until separation or promotion occurs. Three methods of survival analysis are used for the analysis-- survival pattern analysis, parametric regression models and Cox (non-parametric) regression models.

For survival pattern analysis, the life-table method is used, because the data set is too large to use Kaplan-Meier method which gives survival pattern results for each individual in the data set. The life-table method yields results from grouping the observations into time intervals. Both methods give the probability that a person will survive until the time $t+1$, given that he or she has survived until the time t. Both methods also provide the probability of not surviving (separate or not promote) during the same time frame. [124] The life-table method produces estimates and plots of the hazard function.[125] The survival and hazard functions of all officers in the data set and of

[124] Allison, 29-41.

[125] Ibid., 41.

officers with different education levels are plotted in order to observe service time and promotion time patterns. Plotting the survival and hazard functions of officers with different education levels shows the differences in both service time and time to promotion to O-4, according to their educational level.

Parametric models for duration produce results that show the effects of explanatory variables on survival times. That is, for binary variables, they produce the estimated mean difference in survival times for two groups, and for continuous variables, they give the percent increase (decrease) in the estimated survival time for each one unit increase in the variable.[126] Thus, parametric models show the service time differences for retention analysis, and the time differences in time to promotion to major for promotion analysis.

Cox regression models (nonparametric models for event outcomes) provide the results for the hazard function which produces partial effects on the probability of occurrence of the events. Thus, for the retention model used in this thesis, they provide the effects of independent variables on the hazard of separation of Army officers. For the promotion model, they show the effects of explanatory variables on the hazard of being promoted to major.

Three SAS software procedures are used in order to find the survival and hazard functions of officers for retention and promotion. PROC LIFETEST is used for survival pattern analysis, PROC LIFEREG is used for estimating parametric models for duration analysis and PROC PHREG is used for estimating Cox regression results (nonparametric models for event occurrences). The PROC LIFETEST procedure is useful for preliminary analysis and plotting the survival and hazard functions. Furthermore, PROC LIFETEST shows the differences in these functions between groups. PROC LIFEREG is used to find the effect of explanatory variables on duration. PROC PHREG produces the partial effect of variables on hazard function.

[126] Allison, 65.

1. Retention Analysis

Results of analysis of the survival and hazard functions show that there is an increase in separation rates between years 4 and 6 which marks the end of the initial service obligation of officers, depending on their commissioning sources. Then there is another increase in hazard function between years 12 and 14, which is the point for both promotion to major and the end of service obligation related to graduate education. Finally, the sharpest decrease in service time (survival function) and the sharpest increase in the hazard function for separation occur in the twentieth year, which is the year when officers are eligible for retirement.

Results of the log-rank, Wilcoxon, and likelihood-ratio tests show that survival functions differ significantly with the level of education. College graduates have the lowest survival function, whereas the officers with master's degrees have the highest survival function.

Results of the LIFEREG procedure show the effect of independent variables on the duration time until the event (separation) occurs. Table 33 summarizes results of the LIFEREG procedure for the retention model. Since the gamma distribution fits the data best, results of that distribution are displayed on the table. The percentage effects are calculated and presented in the *LIFEREG (EFFECT)* column. The signs of coefficients in the LIFEREG column show the direction of the effect of a variable on the survival function or service time. The numbers in the table show the percentage effect of that variable when compared to the base case for binary variables, and for each additional one unit increase for continuous variables.

The results of the LIFEREG procedure show that all types of advanced education have positive effects on the retention of Army officers. The expected survival time of an officer with a master's degree is 29.13 percent greater than that of an officer who has only a baccalaureate degree, accounting for other covariates. The expected survival time of an officer with a doctorate degree is 23.94 percent greater than that of an officer who has only a baccalaureate degree, and the expected survival time of an officer with a

professional degree is 8.21 percent greater than that of an officer who has only a baccalaureate degree, accounting for other covariates.

Table 33. Results of LIFEREG and PHREG Procedures for Retention Model

VARIABLE	LIFEREG (EFFECT)	PHREG (HAZARD RATIO)
EDUCATION VARIABLES		
COLLEGEDEGREE	**BASE**	
GRADUATEDEGREE	29.13***	0.383***
DOCTORATEDEGREE	23.94***	0.444***
PROFESSIONALDEGREE	8.21***	0.756***
DEMOGRAPHIC VARIABLES		
FEMALE	-5.56***	1.354***
MARRIED	14.74***	0.67***
ENTRYAGE	-1.12***	1.029***
WHITE	**BASE**	
BLACK	4.50***	0.759***
HISPANIC	4.11***	0.837***
OTHERRACE	3.97***	0.864***
COMMISSIONING SOURCE		
ACADEMY	**BASE**	
ROTCSCHOLAR	--	0.931***
ROTCNONSCHOLAR	6.98***	0.662***
OTHERSOURCE	3.49***	0.739***
PRIOR ENLISTMENT STATUS		
PREENLIST	5.40***	0.811***
MILITARY OCCUPATIONAL SPECIALTY		
COMBATARMS	**BASE**	
COMBATSUPPORT	-2.11*	1.154***
COMBATSERVICESUPPORT	-2.72***	1.106***
SPECIALBRANCHES	-5.62***	1.273***

* Significant at 0.10 level
** Significant at 0.05 level
*** Significant at 0.01 level
-- No significant effect

Source: Author

Other findings of the LIFEREG procedure are as follows:

- Female officers have shorter service times than male officers.

- Being married, being in a minority group and being prior enlisted increase service time.
- An increase in the entry age has a negative effect on survival time.
- Officers commissioned through ROTC non-scholarship and through sources other than USMA, ROTC scholarship and ROTC nonscholarship have longer survival times than USMA graduates.
- Being commissioned through the ROTC scholarship program (ROTCSCHOLAR) has no significant effect on service time compared to an Academy graduate.
- Officers in the combat arms field have longer service times than those in other branches.

Results of the PHREG procedure are also presented in Table 33. The hazard ratios of all of the education variables are less than one, indicating that the hazard of leaving the service for officers with advanced education degrees is less than that of college graduates. An officer with a master's degree has a hazard of leaving that is 38.3 percent of that of an officer with just a college degree (base case) (61.7 percent less), controlling for the other variables. The hazard of separation for an officer with a doctorate degree is 55.6 percent less than that of an officer with a college degree, ceteris paribus. An officer with a professional degree has a hazard of leaving the service that is 75.6 percent of that of a college graduate, when controlling for other factors.

Other findings of the PHREG PROCEDURE are as follows:

- Female officers and officers serving in occupational categories other than combat arms have higher hazards of separation than males and combat arms officers.
- Married officers, minorities, officers commissioned through any source other than USMA, and prior enlisted officers have lower hazards of leaving the Army.
- Each year increase in the age at entry increases the hazard of separating.

2. Promotion Analysis

The survival function in the promotion model shows how long it takes to be promoted to major. The survival function is flat until the tenth year, indicating that almost

no one is promoted during that time. Then, it begins to decrease gradually until the twelfth year, indicating that a small number of officers are promoted during that time. The function then decreases sharply until the fourteenth year, highlighting the period during which most officers are promoted to major. Then, it gradually declines until the seventeenth year, which is the last year when officers are promoted to O-4 in the sample. After that year, the value of the function is zero, showing that no one is promoted.

Analysis of the hazard function yields the same results. The hazard of being promoted to O-4 begins to increase slightly at about the tenth year. There is a sharp increase in the hazard of promotion after the twelfth year. Then it begins to decline at the thirteenth year. There is a small increase in the sixteenth year, indicating that the hazard of promotion increases slightly during that year. It then declines and becomes zero at year 17, again showing that no promotions to O-4 occur after that time, as for the survivor function.

According to results of the log-rank, Wilcoxon, and likelihood-ratio tests, the survival (promotion) functions of officers differ significantly according to their education levels. Test results are significant at all usual levels.

Survival functions for officers with different education levels for promotion analysis show that professional degree holders have the lowest survival curve, indicating that those officers are promoted in shorter times than the other categories. Master's degree holders and college graduates have very similar survival functions, indicating that their promotion time to O-4 is almost equal. However, analysis of hazard functions based on education level clearly shows that the promotion hazards of officers with or without master's degrees do differ. The sharpest increase in the hazard function (hazard of being promoted to major) is observed for officers who have master's degrees.

Results of the LIFEREG and PHREG procedures for the promotion model are summarized in Table 34. The signs of coefficients in the LIFEREG column show the direction of the effect of a variable on the time that it takes to be promoted to O-4. A positive sign indicates that the variable increases promotion time when compared to the base case, for binary variables. If the variable is continuous, it shows the increase in time

that it takes to be promoted when this variable is increased by one unit. The number in the *effect* column shows the percentage effect of that variable when compared to the base case for binary variables, and the percentage effect of each additional unit increase for continuous variables.

Table 34. Results of LIFEREG and PHREG Procedures for Promotion Model

VARIABLE	LIFEREG (EFFECT)	PHREG (HAZARD RATIO)
EDUCATION VARIABLES		
COLLEGEDEGREE	**BASE**	
GRADUATEDEGREE	-0.21**	1.153***
PROFESSIONALDEGREE	-2.43***	--
DEMOGRAPHIC VARIABLES		
FEMALE	-0.52***	1.165***
MARRIED	--	1.156***
ENTRYAGE	-0.14***	--
WHITE	**BASE**	
BLACK	0.50***	0.802***
HISPANIC	--	--
OTHERRACE	-0.58**	--
COMMISSIONING SOURCE		
ACADEMY	**BASE**	
ROTCSCHOLAR	--	--
ROTCNONSCHOLAR	--	--
OTHERSOURCE	-1.01***	1.105**
PRIOR ENLISTMENT STATUS		
PREENLIST	-0.65***	1.102***
MILITARY OCCUPATIONAL SPECIALTY		
COMBATARMS	**BASE**	
COMBATSUPPORT	0.37**	--
COMBATSERVICESUPPORT	-0.41***	--
SPECIALBRANCHES	-4.18***	1.648***

* Significant at 0.10 level
** Significant at 0.05 level
*** Significant at 0.01 level
-- No significant effect

Source: Author

As seen in Table 34, advanced education decreases the time for promotion to major. The expected time for promotion to O-4 for an officer with a master's degree is 0.21 percent less than that for an officer who has only a baccalaureate degree, accounting for other covariates. The expected time for promotion to major for an officer with a professional degree is 2.43 percent less than that for an officer who has only a baccalaureate degree, accounting for other covariates. Other findings of the LIFEREG procedure are as follows:

- Female officers, officers of other race, officers commissioned through other sources, prior enlistees, and officers in combat service support and special branches have shorter promotion times than officers who are male, white, USMA graduates, nonprior enlistees and officers serving in combat arms, respectively.
- Being black and serving in the combat support field increase time for promotion to major.
- Officers who are younger at entry have longer times to promotion to major.
- Being married, Hispanic and commissioned through ROTC (with or without scholarship) have no significant effect on promotion time.

According to the PHREG results, a professional degree has no significant effect on the hazard of being promoted. However, a master's degree or a doctorate degree has a positive effect on the hazard of being promoted. An officer with a master's degree or a doctorate has a hazard of promotion that is 115.3 percent of that of an officer with a college degree (base case) (15.3 percent more), other things being equal. Other findings of the PHREG procedure are as follows:

- Female officers, married officers, prior enlisted officers and those serving in special branches have higher hazards of being promoted to major than males, single officers, nonprior enlistees and those serving in combat arms, respectively:
- Black officers have a lower hazard of being promoted to O-4 than whites.
- Officers commissioned through sources other than USMA and ROTC (with or without scholarship) have higher hazards of being promoted to O-4 than USMA graduates.

- Entry age, being Hispanic or other race, being commissioned through ROTC (with or without scholarship), and serving in the combat support or combat service support categories have no significant effect on the hazard of being promoted to the grade of O-4.

B. CONCLUSIONS

Human capital theory suggests that when workers make investments in education and training, the expected returns are higher future earnings, increased job satisfaction over their lifetimes, and other quality of life improvements. Results of this study show that officers with advanced education are more likely to be retained and are also more likely to be promoted to major, which corroborates human capital theory.

Results of this study indicate that officers with advanced education degrees (those who made an investment in education) have longer service times than officers who did not invest in advanced education and are less likely to leave the Army. This result may be interpreted as an indicator that advanced education leads to increased job satisfaction among officers over their lifetimes as a result of investing in advanced education and contributes to their desire to remain in the Army.

In the Army compensation differs according to an officer's rank. Thus, if an officer is promoted more rapidly, then he or she increases his or her earnings. The results of this thesis about the relationship of Army officer promotion and level of education are similar to those found in the literature, including Buterbaugh (1995), Wielsma (1996), Bowman and Mehay (1998), Branigan (2001) , Kabalar (2003) and Kizilkaya (2004). All of these studies found that advanced education has a positive effect on officer promotion. This thesis also finds that possessing an advanced degree significantly decreases the time for promotion to major and increases the probability of being promoted to O-4 for Army officers. Thus, acquiring advanced education benefits these officers by increasing their earnings, as predicted by human capital theory.

Another explanation for the higher earnings of those with more education is the concept of education as a signal. If those who have lower costs of acquiring education are also of higher ability and are more productive on the job, then educational level serves as

a useful signal for employers in screening for employment and promotion.[127] The results of this study are also consistent with this approach. Army officers who obtain advanced education are found to be more likely to be promoted and are promoted more quickly than those who have not acquired these degrees. Thus, advanced degrees may serve as signals to the Army (the employer) regarding officers' superior abilities and productivity.

C. LIMITATIONS

Although the data set includes information on more than 100,000 officers, only 45,228 observations are used for retention analysis and 12,092 for promotion analysis due to missing and unknown values in some of the data fields. The main focus of this study is the effect of education level of officers on retention and promotion. However, in the data set, the education level of about 90,000 officers was miscoded or was unknown. As a result, observations with miscoded or unknown education levels were deleted from the database, which substantially limited the number of officers used for analysis.

Some variables that were used in previous studies on the effects of level of education on retention and/or promotion were not available in the data set and could not be used in the analysis. These variables include the college grade point average of an officer, performance reports, whether an officer separated voluntarily, the quality of the college from which the officer graduated, awards received, and the officer's alma mater for graduate education (military or civilian). These omitted variables have the potential to bias some of the study's results.

D. RECOMMENDATIONS

1. Improvement and Expansion of Data and Suggestions for Future Research

This study mainly examines the relationship between the education level of Army officers and their retention decisions or their promotion to major. The data were not available to determine where the officers obtained their master's or doctorate degrees. To find out the differences in service times and in promotion probabilities between officers

[127] Ronald G. Ehrenberg and Robert S. Smith, *Modern Labor Economics,* 9th ed. (New York: Pearson Education, Inc, 2006), 277.

who obtained their degrees from a military institution such as the Naval Postgraduate School (NPS) or from civilian universities would provide interesting information to the Army. The Army would thus be able to compare the costs and benefits of different educational institutions in for decision-making regarding human capital investment.

Another extension of this analysis could be used to compare the costs and benefits of advanced degree programs with military training. This approach would focus on the promotion and service time differences between officers who received master's degree from any institution, and those who had advanced training on firm-specific issues, that is, on military subjects.

Identifying advanced education as fully funded, partially funded and unfunded and estimating the retention and promotion differences among officers who received different kinds of funding would also provide helpful information for the Army. However, for this study the data were not available to differentiate the officers according to their utilizing the Army funds.

The data used for this study do not distinguish between officers who leave the Army voluntarily and those who leave involuntarily. More accurate conclusions about retention decisions might be drawn if it were possible to categorize the officers who separated into these two groups.

2. Policy Recommendations

The results of this study have important implications for Army education policy. Advanced education significantly increases the length of time that Army officers serve on active duty, and significantly decreases their probability of separation from the Army. Furthermore, advanced education significantly increases the likelihood of Army officers being promoted to the rank of O-4, and decreases the time for promotion to O-4. For these reasons, the Army should place great importance on the education of officers at advanced education institutions in order to obtain the benefits of investment in human capital, which, for the Army, means increased productivity and readiness.

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APPENDIX A. DISTRIBUTION AND RETENTION RATES AS OF SEPTEMBER 30, 2004 FOR ALL ARMY OFFICERS ENTERING 1981-2004 IN NUMBERS (AND PERCENT)

VARIABLE	NUMBER	STAY	LEAVE
TOTAL OFFICERS	45,228(100%)	33,232(73.48%)	11,996(26.52%)
EDUCATION VARIABLES			
COLLEGE DEGREE	26,781(59.21%)	18,193(67.93%)	8,588(32.07%)
MASTER'S DEGREE	13,403(29.63%)	11,577(86.38%)	1,826(13.62%)
DOCTORATE	432(0.96%)	334(77.31%)	98(22.69%)
PROFESSIONAL	4612(10.2%)	3,128(67.82%)	1,484(32.18%)
DEMOGRAPHIC VARIABLES			
MALE	38,147(84.34%)	28,660(75.13%)	9,487(24.87%)
FEMALE	7,081(15.66%)	4,572(64.57%)	2,509(35.43%)
MARRIED	33,788(74.71%)	26,104(77.0%)	7,684(23.0%)
SINGLE	11,440(25.29%)	7,128(62.0%)	4,312(38.0%)
WHITE	35,759(79.06%)	25,983(72.66%)	9,776(27.34%)
BLACK	5,227(11.56%)	4,102(78.48%)	1,125(21.52%)
HISPANIC	1,731(3.83%)	1,322(76.37%)	409(23.63%)
OTHER RACE	2,511(5.55%)	1,825(72.68%)	686(27.32)
COMMISSIONING SOURCE			
USMA	7,977(17.64%)	5,455(68.38%)	2,522(31.62%)
ROTC SCHOLAR	12,599(27.86%)	8,493(67.41%)	4,106(32.59%)
ROTC	14,643(32.38%)	11,831(80.80%)	2,812(19.20%)
OTHER SOURCE	10,009(22.13%)	7,453(74.46%)	2,556(25.54%)
PRIOR ENLISTMENT STATUS			
PRIOR ENLISTED	16,006(35.39%)	12,594((78.68%)	3,412(21.32%)
NONPRIOR	29,222(64.61%)	20,638(70.62%)	8,584(29.38%)
OCCUPATIONAL CATEGORY			
COMBAT ARMS	26,758(59.16%)	20,189(75.45%)	6,569(24.55%)
COMBAT SUPPORT	3,323(7.35%)	2,365(71.17%)	958(28.83%)
COMBAT SERVICE	5,420(11.98%)	3,967(73.19%)	1,453(26.81%)
SPECIAL BRANCHES	9,727(21.51%)	6,711(68.99%)	3,016(31.01%)

Source: Author tabulations based on DMDC data

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APPENDIX B. DISTRIBUTION AND PROMOTION RATES TO MAJOR AS OF SEPTEMBER 30, 2004 FOR ALL ARMY OFFICERS ENTERING 1981-2004 IN NUMBERS (AND PERCENT)

VARIABLE	NUMBER (PERCENT)	PROMOTED	NOT PROMOTED
TOTAL OFFICERS	12,092(100%)	6,742(55.76%)	5,350(44.24%)
EDUCATION VARIABLES			
COLLEGE DEGREE	8,282(68.49%)	3,722(44.94%)	4,560(55.06%)
MASTER'S DEGREE	3,698(30.58%)	2,925(79.10%)	773(20.90%)
DOCTORATE DEGREE	20(0.17%)	14(70.00%)	6(30.00%)
PROFESSIONAL DEGREE	92(0.76%)	81(88.04%)	11(11.96%)
DEMOGRAPHIC VARIABLES			
MALE	10,448(86.40%)	5,900(56.47%)	4,548(43.53%)
FEMALE	1,644(13.60%)	842(51.22%)	802(48.78%)
MARRIED	9,934(82.15%)	5,859(58.98%)	4,075(41.02%)
SINGLE	2,158(17.85%)	883(40.92%)	1,275(59.08%)
WHITE	10,156(83.99%)	5,752(56.64%)	4,404(43.36%)
BLACK	1,320(10.92%)	673(50.98%)	647(49.02%)
HISPANIC	215(1.78%)	105(48.84%)	110(51.16%)
OTHER RACE	401(3.32%)	212(52.87%)	189(47.13)
COMMISSIONING SOURCE			
USMA	2,801(23.16%)	1,582(56.48%)	1,219(43.52%)
ROTC SCHOLAR	2,216(18.33%)	1,119(50.50%)	1,097(49.50%)
ROTC NONSCHOLAR	5,566(46.03%)	3,117(56.00%)	2,449(44.00%)
OTHER SOURCE	1,509(12.48%)	924(61.20%)	585(38.80%)
PRIOR ENLISTMENT STATUS			
PRIOR ENLISTED	2,578(21.32%)	1,393(54.03%)	1,185(45.97%)
NONPRIOR ENLISTED	9,514(78.68%)	5,349(56.22%)	4,165(43.78%)
OCCUPATIONAL CATEGORY			
COMBAT ARMS	8,461(69.97%)	4,700(55.55%)	3,761(44.45%)
COMBAT SUPPORT	1,080(8.93%)	582(53.89%)	498(46.11%)
COMBAT SERVICE SUPPORT	1,407(11.64%)	763(54.23%)	644(45.77%)
SPECIAL BRANCHES	1,144(9.46%)	697(60.93%)	447(39.07%)

Source: Author tabulations based on DMDC data

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